OPERATING AND SERVICE MANUAL

MASTER

DC POWER SUPPLY

MPB-5 SERIES, MODEL 6285A

SERIAL NUMBER PREFIX 6K

HEWLETT hp PACKARD

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LM

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SECTION I
GENERAL INFORMATION

1-1 DESCRIPTION

1-2 This power supply, Figure 1-1, is completely transistorized and suitable for either bench or relay rack operation. It is a compact, well-regulated, Constant Voltage / Constant Current supply that will furnish full rated output voltage at the maximum rated output current or can be continuously adjusted throughout the output range. The front panel CURRENT controls can be used to establish the output current limit (overload or short circuit) when the supply is used as a constant voltage source and the VOLTAGE control can be used to establish the voltage limit (ceiling) when the supply is used as a constant current source. The supply will automatically crossover from constant voltage to constant current operation and vice versa if the output current or voltage exceeds these preset limits.

1-3 The power supply has both front and rear terminals. Either the positive or negative output terminal may be grounded or the power supply can be operated floating at up to a maximum of 300 volts off ground.

1-4 A single meter is used to measure either output voltage or output current in one of two ranges. The voltage or current ranges are selected by a METER switch on the front panel.

1-5 Barrier strip terminals located at the rear of the unit allow ease in adapting to the many operational capabilities of the power supply. A brief description of these capabilities is given below:

a. Remote Programming

The power supply may be programmed from a remote location by means of an external voltage source or resistance.

b. Remote Sensing

The degradation in regulation which would occur at the load because of the voltage drop in the load leads can be reduced by using the power supply in the remote sensing mode of operation.

c. Series and Auto-Series Operation

Power supplies may be used in series when a higher output voltage is required in the voltage mode of operation or when greater voltage compliance is required in the constant current mode of operation. Auto-Series operation permits one knob control of the total output voltage from a "master" supply.

d. Parallel and Auto-Parallel Operation

The power supply may be operated in parallel with a similar unit when greater output current capability is required. Auto-Parallel operation permits one knob control of the total output current from a "master" supply.

e. Auto-Tracking

The power supply may be used as a "master" supply having control over one (or more) "slave" supplies that furnish various voltages for a system.

1-6 SPECIFICATIONS

1-7 Detailed specifications for the power supply are given in Table 1-1.

1-8 OPTIONS

1-9 Options are factory modifications of a standard instrument that are requested by the customer. The following options are available for the instrument covered by this manual. Where necessary, detailed coverage of the options is included throughout the manual.

Option No.	Description
05	50 Hz Regulator Realignment: Standard instruments will operate satisfactorily at both 60 and 50 Hz without adjustment. However Option 05 factory realignment results in more efficient operation at 50 Hz, and is recommended for all applications when continuous operation from a 50 Hz ac input is intended.

Option No.	Description
07	Voltage 10-Turn Control: A single control that replaces both coarse and fine voltage controls and improves output settability.
08	Current 10-Turn Control: A single control that replaces both coarse and fine current controls and improves output settability.
09	Voltage and Current 10-Turn Controls: Options 07 and 08 on same instrument.
11	Internal Overvoltage Protection "Crowbar": Operating and Service information is included in Appendix A at the rear of the manual.
13	Three Digit Graduated Decadial Voltage Control: Control that replaces 10-turn voltage control permitting accurate resettability.
14	Three Digit Graduated Decadial Current Control: Control that replaces coarse and fine current controls permitting accurate resettability.
28	230V AC, Single Phase, Input: Supply is shipped for 115V ac operation. Option 28 consists of modifying the supply for 230Vac operation.

1-10 ACCESSORIES

1-11 The accessories listed in the following chart may be ordered with the power supply or separately from your local Hewlett-Packard field sales office (refer to list at rear of manual for addresses).

Ⓗ Part No.	Description
14515A	Rack Kit for mounting one $5\frac{1}{4}$" high supply. (Refer to Section II for details.)
14525A	Rack Kit for mounting two $5\frac{1}{4}$" high supplies. (Refer to Section II for details.)

1-12 INSTRUMENT IDENTIFICATION

1-13 Hewlett-Packard power supplies are identified by a three-part serial number tag. The first part is the power supply model number. The second part is the serial number prefix, which consists of a number-letter combination that denotes the date of a significant design change. The number designates the year, and the letter A through M designates the month, January through December respectively. The third part is the power supply serial number.

1-14 If the serial number prefix on your power supply does not agree with the prefix on the title page of this manual, change sheets are included to update the manual. Where applicable, backdating information is given in an appendix at the rear of the manual.

1-15 ORDERING ADDITIONAL MANUALS

1-16 One manual is shipped with each power supply. Additional manuals may be purchased from your local Hewlett-Packard field office (see list at rear of this manual for addresses). Specify the model number, serial number prefix, and Ⓗ stock number provided on the title page.

INPUT
105-125 VAC single phase 50 60Hz.
3.5A 160W.

OUTPUT:
0-25 volts @ 0-5 amps.

LOAD REGULATION:
Constant Voltage -- Less than 0.01% plus 1mV for a full load to no load change in output current.
Constant Current -- Less than 0.05% plus 1mA for a zero to maximum change in output voltage.

LINE REGULATION:
Constant Voltage -- Less than 0.01% plus 1mV for any line voltage change within the input rating.
Constant Current -- Less than 0.05% plus 1mA for any line voltage change within the input rating.

RIPPLE AND NOISE:
Constant Voltage -- Less than 100μV rms
Constant Current -- Less than 3mArms

OPERATING TEMPERATURE RANGES:
Operating: 0 to 50°C. Storage: -20 to +85°C.

TEMPERATURE COEFFICIENT:
Constant Voltage -- Less than 0.02% plus 500μV per degree Centigrade.
Constant Current -- Less than 0.02% plus 3mA per degree Centigrade.

STABILITY:
Constant Voltage -- Less than 0.10% plus 2.5mV total drift for 8 hours after an initial warm-up time of 30 minutes at constant ambient, constant line voltage, and constant load.
Constant Current -- Less than 0.10% plus 12.5mA total drift for 8 hours after an initial warm-up time of 30 minutes at constant ambient, constant line voltage and constant load.

INTERNAL IMPEDANCE AS A CONSTANT VOLTAGE SOURCE
Less than 0.001 ohm from DC to 100Hz
Less than 0.01 ohm from 100Hz to 1kHz
Less than 0.2 ohm from 1kHz to 100kHz
Less than 2.0 ohms from 100 kHz to 1 MHz

TRANSIENT RECOVERY TIME:
Less than 50μsec for output recovery to within 15 mV following a current change in the output equal to the current rating of the supply or 5 amperes, whichever is smaller.

OVERLOAD PROTECTION
A continuously acting constant current circuit protects the power supply for all overloads including a direct short placed across the terminals in constant voltage operation. The constant voltage circuit limits the output voltage in the constant current mode of operation.

METER
The front panel meter can be used as either a 0-24 or 0-2.4 volt voltmeter or as a 0-6 or 0-0.6 amp ammeter.

OUTPUT CONTROLS:
Coarse and fine voltage controls and coarse and fine current controls provide continuous adjustment over the entire output span.

OUTPUT TERMINALS:
Three "five-way" output posts are provided on the front panel and an output terminal strip is located on the rear of the chassis. All power supply output terminals are isolated from the chassis and either the positive or negative terminal may be connected to the chassis through a separate ground terminal. If the front panel terminals are used, the load regulation will be 0.5mV per ampere greater than at the front terminal specification.

ERROR SENSING:
Error sensing is normally accomplished at the front terminals if the load is attached to the front or at the rear terminals if the load is attached to the rear terminals. Also, provision is included on the rear terminal strip for remote sensing.

REMOTE PROGRAMMING:
Remote programming of the supply output at approximately 200 ohms per volt in constant voltage is made available at the rear terminals. In constant current mode of operation, the current can be remotely programmed at approximately 250 ohms per ampere.

COOLING:
Convection cooling is employed. The supply has no moving parts.

SIZE:
5¼" H x 16" D x 8½" W. Two of the units can be mounted side by side in a standard 19" relay rack.

WEIGHT:
25 lbs. net 32 lbs. shipping

FINISH:
Light gray front panel with dark gray case

POWER CORD:
A three-wire, five foot power cord is provided with each unit.

2-1 INITIAL INSPECTION

2-2 Before shipment, this instrument was inspected and found to be free of mechanical and electrical defects. As soon as the instrument is unpacked, inspect for any damage that may have occurred in transit. Save all packing materials until the inspection is completed. If damage is found, proceed as described in the Claim for Damage in Shipment section of the warranty page at the rear of this manual.

2-3 MECHANICAL CHECK

2-4 This check should confirm that there are no broken knobs or connectors, that the cabinet and panel surfaces are free of dents and scratches, and that the meter is not scratched or cracked.

2-5 ELECTRICAL CHECK

2-6 The instrument should be checked against its electrical specifications. Section V includes an "in-cabinet" performance check to verify proper instrument operation.

2-7 INSTALLATION DATA

2-8 The instrument is shipped ready for bench operation. It is necessary only to connect the instrument to a source of power and it is ready for operation.

2-9 LOCATION

2-10 This instrument is air cooled. Sufficient space should be allotted so that a free flow of cooling air can reach the sides and rear of the instrument when it is in operation. It should be used in an area where the ambient temperature does not exceed 50°C.

2-11 RACK MOUNTING

2-12 This instrument may be rack mounted in a standard 19 inch rack panel either alongside a similar unit or by itself. Figures 2-1 and 2-2 show how both types of installations are accomplished.

2-13 To mount two units side-by-side, proceed as follows:

a. Remove the four screws from the front panels of both units.

b. Slide rack mounting ears between the front panel and case of each unit.

c. Slide combining strip between the front panels and cases of the two units.

d. After fastening rear portions of units together using the bolt, nut, and spacer, replace panel screws.

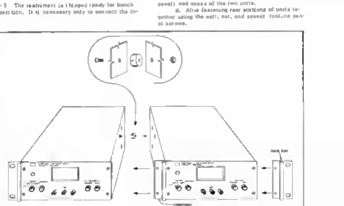


Figure 2-1. Rack Mounting, Two Units

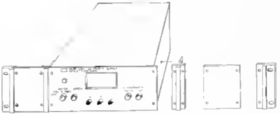


Figure 2-2 Rack Mounting, One Unit

2-14 To mount a single unit in the rack panel, proceed as follows

a. Bolt rack mounting ears, combining straps and angle brackets to each side of center spacing panels. Angle brackets are placed behind combining straps as shown in Figure 2-2.

b. Remove four screws from front panel of unit

c. Slide combining strips between front panel and case of unit

d. Bolt angle brackets to front sides of case and replace front panel screws

2-15 <u>INPUT POWER REQUIREMENTS</u>

2-16 This power supply may be operated from either a nominal 115 volt or 230 volt 50-60 cycle power source. The unit, as shipped from the factory, is wired for 115 volt operation only. A factory modification (Option 18) must be made to permit operation from a 230 volt line. The input power required when operated from a 115 volt, 60 cycle power source at full load is given in the specification table in Section I.

2-17 50 Hz OPERATION

2-18 The unit as normally shipped from the factory can be operated from either a 50 or 60 Hz source. However, with a 50 Hz input, the operation of the unit may become somewhat degraded when the temperature exceeds 35° Centigrade (instead of the normal 50° Centigrade capability with a 60 Hz input). To permit optimum operation at 50 Hz, the unit must be realigned. This realignment procedure is described in Paragraph 5-54 at the rear of the manual.

2-19 POWER CABLE

2-20 To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three conductor power cable. The third conductor is the ground conductor and when the cable is plugged into an appropriate receptacle the instrument is grounded. The offset pin on the power cable three-prong connector is the ground connection.

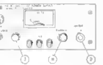
2-21 To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to ground.

2-22 <u>REPACKAGING FOR SHIPMENT</u>

2-23 To insure safe shipment of the instrument it is recommended that the package designed for the instrument be used. The original packaging material is reusable. If it is not available contact your local Hewlett-Packard field office to obtain the materials. This office will also furnish the address of the nearest service office to which the instrument can be shipped. Be sure to attach a tag to the instrument which specifies the owner, model number, full serial number and service required, or a brief description of the trouble.

3-1 OPERATING CONTROLS AND INDICATORS

3-2 The front panel controls and indicators, together with the normal turn-on sequence, are shown in Figure 3-1.



TURN-ON SEQUENCE

[illegible]

Figure 3-1. Front Panel Controls and Indicators

3-3 OPERATING MODES

3-4 The power supply is designed so that its mode of operation can be selected by making strapping connections between particular terminals on the terminal strip at the rear of the power supply. The terminal designations are stenciled in white on the power supply above their respective terminals. Although the strapping patterns illustrated in this section show the positive terminal grounded, the operator can ground either terminal or operate the power supply up to 300 vdc off ground (floating). The following paragraphs describe the procedures for utilizing the various operational capabilities of the power supply. A more theoretical description concerning the operational features of this supply is contained in a power supply Application Manual and in various Tech. Letters published by the Harrison Division. Copies of these can be obtained from your local Hewlett-Packard field office.

3-5 NORMAL OPERATING MODE

3-6 The power supply is normally shipped with its rear terminal strapping connections arranged for Constant Voltage/Constant Current, local sensing, local programming, single unit mode of operation. This strapping pattern is illustrated in Figure 3-2. The operator selects either a constant voltage or a constant current output using the front panel controls (local programming, no strapping changes are necessary).

Figure 3-2. Normal Strapping Pattern

3-7 CONSTANT VOLTAGE

3-8 To select a constant voltage output, proceed as follows:

a. Turn-on power supply and adjust VOLTAGE controls for desired output voltage (output terminals open).

b. Short output terminals and adjust CURRENT controls for maximum output current allowable (current limit), as determined by load conditions. If a load change causes the current limit to be exceeded, the power supply will automatically crossover to constant current output at the preset current limit and the output voltage will drop proportionately. In setting the current limit, allowance must be made for high peak current which can cause unwanted cross-over. (Refer to Paragraph 3-46).

3-9 CONSTANT CURRENT

3-10 To select a constant current output, proceed as follows:

a. Short output terminals and adjust CURRENT controls for desired output current.

h. Open output terminals and adjust VOLTAGE controls for maximum output voltage allowable (voltage limit), as determined by load conditions. If a load change causes the voltage limit to be exceeded, the power supply will automatically crossover to constant voltage output at the preset voltage limit and the output current will drop proportionately. In setting the voltage limit, allowance must be made for high peak voltages which can cause unwanted crossover. (Refer to Paragraph 3-13.)

NOTE

When Model 6291A is operated continuously at the crossover region between Constant Voltage/Constant Current, the feedback loop may break into oscillation, particularly in the 0.5A to 1.5A output current range. Although the crossover region is not usually an area of continuous operation, this problem can be eliminated, if necessary, by connecting the emitter of Q??? to ?? (instead of to the emitter of Q301) and readjusting R307. Note that when this is done, the transient recovery time of Model 6291A must be derated to "50μsec for recovery to within 20mV" (instead of 15mV).

3-11 CONNECTING LOAD

3-12 Each load should be connected to the power supply output terminals using separate pairs of connecting wires. This will minimize mutual coupling effects between loads and will retain full advantage of the low output impedance of the power supply. Each pair of connecting wires should be as short as possible and twisted or shielded to reduce noise pickup. (If shield is used, connect one end to power supply ground terminal and leave the other end unconnected.)

3-13 If load considerations require that the output power distribution terminals be remotely located from the power supply, then the power supply output terminals should be connected to the remote distribution terminals via a pair of twisted or shielded wires and each load separately connected to the remote distribution terminals. For this case, remote sensing should be used (Paragraph 3-30).

3-14 OPERATION OF SUPPLY BEYOND RATED OUTPUT

3-15 The shaded area on the front panel meter face indicates the amount of output voltage or current that is available in excess of the normal output. Although the supply can be operated in this shaded region without being damaged, it cannot be guaranteed to meet all of its performance specifications. However, if the line voltage is maintained above 115 Vac, the supply will probably operate within its specifications.

3-16 OPTIONAL OPERATING MODES

3-17 REMOTE PROGRAMMING, CONSTANT VOLTAGE

3-18 The constant voltage output of the power supply can be programmed (controlled) from a remote location if required. Either a resistance or voltage source can be used for the programming device. The wires connecting the programming terminals of the supply to the remote programming device should be twisted or shielded to reduce noise pick-up. The VOLTAGE controls on the front panel are disabled according to the following procedures.

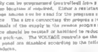


Figure 3-3 Remote Resistance Programming (Constant Voltage)

3-19 Resistance Programming (Figure 3-3). In this mode, the output voltage will vary at a rate determined by the programming coefficient: 200 ohms per volt (300 ohms per volt for Model 6296A). The output voltage will increase 1 volt for each 200 ohms (or 300 ohms) added in series with the programming terminals. The programming coefficient is determined by the programming current. This current is factory adjusted to within 2% of 5 ma (2% of 3.3 ma for Model 6296A). If greater programming accuracy is required, it may be achieved by changing resistor R806.

3-20 The output voltage of the power supply should be zero volts ±20 millivolts when zero ohms is connected across the programming terminals.

3-21 To maintain the stability and temperature coefficient of the power supply, use programming resistors that have stable, low noise, and low temperature (less than 30 ppm per degree Centigrade) characteristics. A switch can be used in conjunction with various resistance values in order to obtain discrete output voltages. The switch should have make-before-break contacts to avoid momentarily opening the programming terminals during the switching interval.

3-22 Voltage Programming (Figure 3-4). Employ the strapping pattern shown on Figure 3-4 for voltage programming. In this mode, the output voltage will vary in a 1 to 1 ratio with the pro-

gramming voltage (reference voltage) and the load on the programming voltage source will not exceed 25 microamperes.

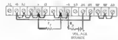


Figure 3-4. Remote Voltage Programming (Constant Voltage)

3-23 The impedance matching resistor (R_X) for the programming voltage source should be approximately 1000 ohms to maintain the temperature and stability specifications of the power supply.

3-24 REMOTE PROGRAMMING, CONSTANT CURRENT

3-25 Either a resistance or a voltage source can be used to control the constant current output of the supply. The CURRENT controls on the front panel are disabled according to the following procedures.

Figure 3-5. Remote Resistance Programming (Constant Current)

3-26 Resistance Programming (Figure 3-5). In this mode, the output current varies at a rate determined by the programming coefficient — 100 ohms per ampere for Models 6282A and 6284A, 200 ohms per ampere for Models 6285A and 6291A, and 500 ohms per ampere for Models 6290A and 6296A. The programming coefficient is determined by the Constant Current programming current 1 mA for Models 6282A, 6285A, 6286A, and 6291A or 0.6 mA for Models 6290A and 6296A. This current is adjusted to within 10% at the factory. If greater programming accuracy is required, it may be achieved by changing resistor R806 as outlined in Section V.

3-27 Use stable, low noise, low temperature coefficient (less than 30 ppm/°C) programming resistors to maintain the power supply temperature coefficient and stability specifications. A switch may be used to set discrete values of output current. A make-before-break type of switch should be used since the output current will exceed the maximum rating of the power supply if the switch contacts open during the switching interval.

CAUTION

If the programming terminals (A1 and A8) should open at any time during this mode, the output current will rise to a value that may damage the power supply and/or the load. To avoid this possibility, connect a 1K resistor (1.5K for Models 6290A and 6296A) across the programming terminals. Like the programming resistor, this resistor should be of the low noise, low temperature coefficient type.

3-28 Voltage Programming (Figure 3-6). In this mode, the output current will vary linearly with changes in the programming voltage. The programming voltage should not exceed 1.5 volts. Voltage in excess of 1.5 volts will result in excessive power dissipation in the instrument and possible damage.

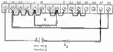


Figure 3-6. Remote Voltage Programming (Constant Current)

3-29 The output current will be the programming voltage divided by the internal current sampling resistance R800. The current required from the voltage source will be less than 25 microamperes. The impedance matching resistor (R_X) should be approximately 1000 ohms if the temperature coefficient and stability specifications of the power supply are to be maintained.

3-30 REMOTE SENSING (See Figure 3-7)

3-31 Remote sensing is used to maintain good regulation at the load and reduce the degradation of regulation which would occur due to the voltage drop in the leads between the power supply and the load. Remote sensing is accomplished by utilizing the strapping pattern shown in Figure 3-8. The power supply should be turned off before changing strapping patterns. It is not required

that these leads be as heavy as the load leads. However, they must be twisted or shielded to minimize noise pick-up.

Figure 3-7. Remote Sensing

CAUTION

Observe polarity when connecting the sensing leads to the load.

3-32 Note that it is desirable to minimize the drop in the load leads and it is recommended that the drop not exceed 1 volt per lead if the power supply is to meet its DC specifications. If a larger drop must be tolerated, please consult a Hewlett-Packard field representative.

NOTE

Due to the voltage drop in the load leads, it may be necessary to readjust the current limit in the remote sensing mode.

3-33 The procedure just described will result in a low DC output impedance at the load. If a low AC impedance is required, it is recommended that the following precautions be taken:

a. Disconnect output capacitor C003 by disconnecting the strap between A2 and +S.

b. Connect a capacitor having similar characteristics (approximately same capacitance, same voltage rating or greater, and having good high frequency characteristics) across the load using short leads.

3-34 Although the strapping patterns shown in Figures 3-3 through 3-6 employ local sensing, note that it is possible to operate a power supply simultaneously in the remote sensing and Constant Voltage/Constant Current remote programming modes.

3-35 SERIES OPERATION

3-36 <u>Normal Series Connections (Figure 3-8).</u>

Two or more power supplies can be operated in series to obtain a higher voltage than that available from a single supply. When this connection is used, the output voltage is the sum of the voltages of the individual supplies. Each of the individual supplies must be adjusted in order to obtain the total output voltage. The power supply contains a protective diode connected internally across the output which protects the supply if one power supply is turned off while its series partner(s) is on.

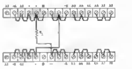


Figure 3-8. Normal Series Connections

3-37 <u>Auto-Series Connections (Figure 3-9).</u> The Auto-Series configuration is used when it is desirable to have the output voltage of each of the series connected supplies vary in accordance with the setting of a control unit. The control unit is called the master; the controlled units are called slaves. At maximum output voltage, the voltage of the slaves is determined by the setting of the front panel VOLTAGE control on the master. The master supply must be the most positive supply of the series. The output CURRENT controls of all series units are operative and the current limit is equal to the lowest control setting. If any output CURRENT controls are set too low, automatic crossover to constant current operation will occur and the output voltage will drop. Remote sensing and programming can be used; however, the strapping arrangements shown in the applicable figures show local sensing and programming.

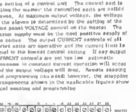


Figure 3-9. Auto-Series, Two Units

3-39 In order to maintain the temperature coefficient and stability specifications of the power supply, the external resistor (R_X) shown in Figure 3-9 should be stable, low noise, low temperature coefficient (less than 30 ppm per degree Centigrade) resistor. The value of this resistor is dependent on the maximum voltage rating of the "master" supply. The value of R_X is this voltage divided by the voltage programming current of the slave supply ($1/K_p$ where K_p is the voltage programming coefficient). The voltage contribution of the slave is determined by its voltage control setting.

3-40 PARALLEL OPERATION

3-41 Normal Parallel Connections (Figure 3-10). Two or more power supplies can be connected in parallel to obtain a total output current greater than that available from one power supply. The total output current is the sum of the output currents of the individual power supplies. The output CURRENT controls of each power supply can be separately set. The output voltage controls of one power supply should be set to the desired output voltage; the other power supply should be set for a slightly larger output voltage. The supply set to the lower output voltage will act as a constant voltage source; the supply set to the higher output will act as a constant current source, dropping its output voltage until it equals that of the other supply. The constant voltage source will deliver only that fraction of its total rated output current which is necessary to fulfill the total current demand.

Figure 3-10. Normal Parallel Connections

3-42 Auto-Parallel. The strapping patterns for Auto-parallel operation of two power supplies are shown in Figure 3-11. Auto-Parallel operation permits equal current sharing under all load conditions, and allows complete control of output current from one master power supply. The output current of each slave will be approximately equal to the master's regardless of the load conditions. Because the output current controls of each slave are operative, they should be set to maximum to avoid having the slave revert to constant current operation; this would occur if the master output current setting exceeded the slave's.

Figure 3-11. Auto-Parallel, Two Units

3-43 AUTO-TRACKING OPERATION (See Figure 3-12)

Figure 3-12. Auto-Tracking, Two Units

3-43 The Auto-Tracking configuration is used when it is necessary that several different voltages referred to a common bus, vary in proportion to the setting of a particular instrument (the control or master). A fraction of the master's output voltage is fed to the comparison amplifier of the slave supply, thus controlling the slave's output. The master must have the largest output voltage of any power supply in the group (must be the most positive supply in the example shown on Figure 3-12).

3-44 The output voltage of the slave is a percentage of the master's output voltage, and is determined by the voltage divider consisting of R_X and the voltage control of the slave supply, R_P, where: $E_P = R_P/R_X + R_P$. Turn-on and turn-off the power supplies is controlled by the master. Remote sensing and programming can be used; although the strapping patterns for these modes show only local sensing and programming. In order to maintain the temperature coefficient and stability specifications of the power supply, the external resistors should be stable, low noise, low temperature (less than 30 ppm per °C) resistors.

3-45 SPECIAL OPERATING CONSIDERATIONS

3-46 PULSE LOADING

3-47 The power supply will automatically cross over from constant voltage to constant current operation, or the reverse, in response to an increase (over the preset limit) in the output current or voltage, respectively. Although the preset limit may be set higher than the average output current or voltage, high peak currents or voltages (as occur in pulse loading) may exceed the preset limit and cause crossover to occur. If this crossover limiting is not desired, set the preset limit for the peak requirement and not the average.

3-48 OUTPUT CAPACITANCE

3-49 An internal capacitor, connected across the output terminals of the power supply, helps to supply high-current pulses of short duration during constant voltage operation. Any capacitance added externally will improve the pulse current capability, but will decrease the safety provided by the constant current circuit. A high-current pulse may damage load components before the average output current is large enough to cause the constant current circuit to operate.

3-50 The effects of the output capacitor during constant current operation are as follows:

a. The output impedance of the power supply decreases with increasing frequency.

b. The recovery time of the output voltage is longer for load resistance changes.

c. A large surge current causing a high power dissipation in the load occurs when the load resistance is reduced rapidly.

3-51 REVERSE VOLTAGE LOADING

3-52 A diode is connected across the output terminals. Under normal operating conditions, the diode is reverse biased (anode connected to negative terminal). If a reverse voltage is applied to the output terminals (positive voltage applied to negative terminal), the diode will conduct, shunting current across the output terminals and limiting the voltage to the forward voltage drop of the diode. This diode protects the series transistors and the output electrolytic capacitor.

3-53 REVERSE CURRENT LOADING

3-54 Active loads connected to the power supply may actually deliver a reverse current to the power supply during a portion of its operating cycle. An external source cannot be allowed to pump current into the supply without loss of regulation and possible damage to the output capacitor. To avoid these effects, it is necessary to preload the supply with a dummy load resistor so that the power supply delivers current through the entire operating cycle of the load device.

SECTION IV
PRINCIPLES OF OPERATION

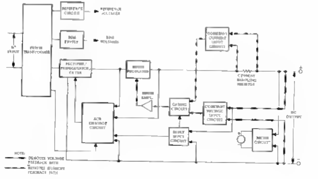


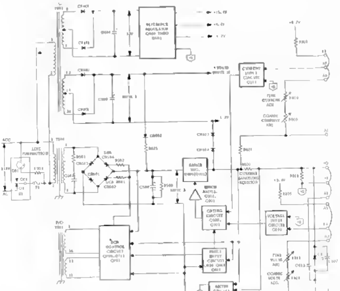
Figure 4-1. Overall Block Diagram

4-1 OVERALL BLOCK DIAGRAM DISCUSSION

4-2 The power supply, as shown on the overall block diagram on Figure 4-1, consists of a power transformer, a rectifier-preregulator-filter, preregulator (SCR) control circuit, series regulator, error amplifiers, gating circuit, a constant voltage input circuit, a constant current input circuit, a fault input circuit, a reference circuit, bias supply, and a meter circuit.

4-3 The input line voltage is reduced to the proper level by the power transformer and coupled to a rectifier bridge consisting of two rectifier diodes and two SCR's. The bridge simultaneously performs the necessary rectifying and preregulating functions. The SCR's, operating in conjunction with a control circuit, minimize the power dissipated by the series regulator by keeping the voltage drop across the regulator at a low and constant level. The SCR control circuit accomplishes this by issuing a firing pulse to one of the SCR's once during each half cycle of the input ac. The control circuit continuously samples the output voltage, the input line voltage, and the voltage across the series regulator and, on the basis of these inputs, determines at what time during each half cycle that the firing pulse will be generated.

4-4 The series regulator, part of another feedback loop, is made to alter its conduction to maintain a constant output voltage or current. Its conduction varies in accordance with feedback control signals obtained from the error amplifier. It should be noted that the series regulator provides fine and "fast" regulation of the output while the preregulator handles large relatively "slow" regulation demands. The dc current from the series regulator passes through a current sampling resistor before reaching the positive output terminal.



NOTES

1. VOLTAGE ACROSS [illegible] FOR EACH MODEL IS SHOWN BELOW.

MODEL NO.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
VOLTS (DC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

2. POSITIVE BUS VOLTAGE FOR EACH MODEL IS SHOWN BELOW

MODEL NO.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
VOLTS (DC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

3. VOLTAGE ACROSS INPUT FILTER CAPACITOR FOR EACH MODEL IS SHOWN BELOW

MODEL NO.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
VOLTS (DC)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 4-2. Simplified Schematic

4-5 The feedback signals that control the conduction of the series regulator are originated within the constant voltage input circuit or the constant current input circuit. The output voltage of the power supply is sampled by the constant voltage input circuit by means of the sensing terminals (±S). The voltage developed across the current sampling resistor is the input to the constant current input circuit. This voltage drop varies in direct proportion to the output current. Any changes in output voltage/current are detected in the constant voltage/constant current input circuit, amplified by the gating and error amplifiers, and applied to the series regulator in the correct phase and amplitude to counteract the changes.

4-6 The fault input circuit detects the presence of overvoltage or overcurrent conditions and generates the necessary turn-down signals to the SCR control circuit or the series regulator circuit. In the case of an overvoltage condition, a turn-down signal is applied to the SCR control circuit. The series regulator receives a turn-down signal via the gating circuit if an overcurrent condition is detected.

4-7 The reference circuit provides stable reference voltages which are used by the constant voltage/current input circuits for comparison purposes. The bias supply furnishes voltages which are used throughout the instrument for biasing purposes. The meter circuit provides an indication of output voltage or current in one of two ranges.

4-8 SIMPLIFIED SCHEMATIC

4-9 A simplified schematic of the power supply is shown in Figure 4-2. It shows the operating controls: the ON-off pushbutton, the voltage programming controls (R413 and R414) and the current programming controls (R409 and R410). The METER switch, included in the meter circuit block on Figure 4-2, allows the meter to read output voltage or current in one of two ranges. Figure 4-2 also shows the internal sources of bias and reference voltages and their nominal magnitudes with an input of 115 Vac and no load connected. Diode CR444, connected across the output terminals of the power supply, is a protective device which prevents internal damage that might occur if a reverse voltage were applied across the output terminals. Output capacitor C509 stabilizes the feedback loop when the normal strapping pattern shown in Figure 4-2 is employed. Note that this capacitor can be removed if an increase in the programming speed is desired. Under these conditions, capacitor C444 serves to insure loop stability. Resistors R514 and R512 limit the output of the supply if the straps between the output and sensing terminals are inadvertently opened.

4-10 DETAILED CIRCUIT ANALYSIS

4-11 PREREGULATOR AND CONTROL CIRCUIT

4-12 The preregulator minimizes changes in the power dissipated by the series regulator due to output voltage or input line voltage changes. Preregulation is accomplished by means of a phase control circuit utilizing SCR's CR500 and CR502 as the switching elements. The appropriate SCR is fired once during each half-cycle (8.33 milliseconds) of the rectified ac (see Figure 4-3). Notice that when the SCR is fired at an early point during the half-cycle, the dc level applied to the series regulator is fairly high. When the SCR is fired later during the cycle, the dc level is relatively low.

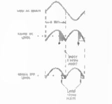


Figure 4-3. SCR Phase Control of DC Input Level

4-13 The SCR control circuit (See Figure 4-4) samples the input line voltage, the output voltage, and the voltage across the series transistor. It generates a firing pulse at the time required to fire the SCR so that the voltage across input capacitor C300 will be maintained at the desired level.

4-14 The inputs to the control circuit are algebraically summed across capacitor C300. All inputs contribute to the time required to charge C300. The input line voltage is rectified by CR303 through CR737, attenuated by voltage divider R700 and R701, and applied to the summing point at TP 33 via capacitor C700. Capacitor C703 is used for smoothing purposes.

4-15 Transistor Q700, connected in a common base configuration, provides a charging current for the timing capacitor which varies in accordance with the input signals applied to its emitter.

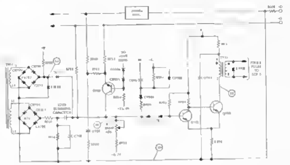


Figure 4-4   SCR Control Circuit, Simplified Schematic

Resistor R713, connected between the negative output line and the emitter of Q702, furnishes a signal which is proportional to the output voltage. Resistors R708 and R707 sample the voltage across and the current through, the series regulator. Capacitor C702 and resistor R709 stabilize the control circuit feedback loop. Resistors R711 and R712 are the source of a constant offset current which sustains a net negative charging current to the summing point, ensuring that the SCR's will fire at low output voltages.

4-10 The summation of the input signals results in the generation of a voltage waveform at TP 59 similar to that shown on Figure 4-5. When the linear ramp section of the waveform reaches a certain negative threshold voltage, diodes CR711 and CR710 become forward biased. The negative voltage then is coupled to the base of transistor Q701. Transistors Q701 and Q700 form a squaring circuit resembling a Schmitt trigger configuration. Q701 is conducting prior to firing time, due to the positive bias connected to its base through R705. Transistor Q700 is cutoff at this time because its base is connected directly to the collector of conducting transistor Q701. When the negative threshold voltage is reached, transistor Q701 is turned off which turns Q700 on. The conduction of Q700 allows capacitor C703 to discharge rapidly through pulse transformer T700 resulting in the SCR firing pulse shown on the

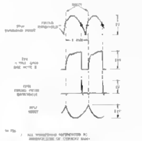


Figure 4-5.   SCR Control Circuit Waveforms

diagram. The firing pulse is relatively narrow because Q700 saturates rapidly causing the magnetic field surrounding T700 to collapse. Diode CR500 clamps out the negative overshoot.

4-17 Reset of the control circuit occurs once every 8.33 milliseconds when the rectified ac voltage at test point 52 recedes to a level at which diode CR709 becomes forward biased. Summing capacitor C700 is then allowed to discharge through CR709. Diodes CR711 and CR710 become reverse biased at reset and transistor Q701 reverts to its "on" state. Consequently Q700 is turned off and capacitor C703 charges up through R703 at a comparatively slow rate until the collector voltage of Q700 reaches approximately +17 volts. The above action causes the small negative spike that appears across the winding of pulse transformer T700 at reset time.

4-18 Capacitor C900, diode CR900, and resistor R900 form a long time constant network which achieves a slow turn-on characteristic. When the unit is first turned on, C900 provides a positive voltage to the cathode of CR711 to insure that it is initially reverse biased. After C900 becomes fully charged, the control circuit is permitted to fire the SCR's. Diode CR902 provides a discharge path for C900 when the unit is turned off.

4-19 SERIES REGULATOR

4-20 The series regulator (transistor Q400 or Q400 and Q401, see schematic at rear of manual) serves as the series, or "pass", element which provides precise and rapid control of the output. The conduction of the series transistor(s) is controlled by the feedback signals obtained from driver Q303. Diode CR400, connected across the regulator circuit, protects the series element(s) from reverse voltages that could develop across them during parallel operation if one supply is turned on before the other.

4-21 CONSTANT VOLTAGE INPUT CIRCUIT (See Figure 4-6)

4-22 The circuit consists of the programming resistors (R113 and R814) and a differential amplifier stage (Q100 and associated components). Transistor Q100 consists of two silicon transistors housed in a single package. The transistors have matched characteristics minimizing differential voltages due to mismatched stages. Moreover, drift due to thermal differentials is minimized, since both transistors operate at essentially the same temperature.

4-23 The constant voltage input circuit continuously compares a fixed reference voltage with a portion of the output voltage and, if a difference exists, produces an error voltage whose amplitude and phase is proportional to the difference. The error output is fed back to the series regulator, through the gating and error amplifiers. The error voltage changes the conduction of the series regulator which, in turn, alters the output voltage

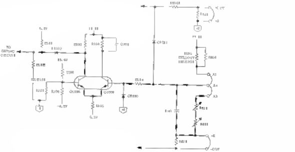


Figure 4-6 Constant Voltage Input Circuit, Simplified Schematic

so that the difference between the two input voltages applied to the differential amplifier is reduced to zero. This action maintains the output voltage constant.

4-24 Stage Q100A of the differential amplifier is connected to a common (+S) potential through impedance equalizing resistor R106. Resistors R102 and R108 are used to zero bias the input stage, offsetting minor base to emitter voltage differences in Q100. The base of Q100B is connected to a summing point (A4) at the junction of the programming resistors and the current pullout resistor R805. Instantaneous changes in the output (due to load variations) or changes due to the manipulation of R813, result in an increase or decrease in the summing point potential. Q100B is then made to conduct more or less, in accordance with summing point voltage change. The change in Q100B's conduction also varies the conduction of Q100A due to the coupling effects of the common emitter resistor R105. The "error" voltage is taken from the collector of Q100A and ultimately varies the conduction of the series regulator.

4-25 Resistor R104, in series with the base of Q100B limits the current through the programming resistors during rapid voltage turn-down. Diodes CR100 and CR101 form a limiting network which prevents excessive voltage excursions from over driving stage Q100B. Capacitor C801, shunting the programming resistors, increases the high frequency gain of the input amplifier. Resistor R806, shunting the pullout resistor, serves as a trimming adjustment for the programming current. Diode CR102 establishes the proper collector bias for Q100A while R103 and C100 provide low frequency equalization for the feedback loop.

4-26 CONSTANT CURRENT INPUT CIRCUIT (See Figure 4-7)

4-27 This circuit is similar in appearance and operation to the constant voltage input circuit. It consists of the coarse and fine current programming resistors (R809 and R810), and a differential amplifier stage (Q200 and associated components). Like transistor Q100 in the voltage input circuit, Q200 consists of two transistors having matched characteristics that are housed in a single package.

4-28 The constant current input circuit continuously compares a fixed reference voltage with the voltage drop across the current sampling resistor. If a difference exists, the differential amplifier produces an "error" voltage which is proportional to this difference. The remaining components in the feedback loop (amplifiers and series regulator) function to maintain the drop across the current sampling resistor and consequently the output current at a constant value.

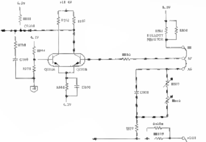


Figure 4-7 Constant Current Input Circuit, Simplified Schematic

4-28 Stage Q300A is connected to the voltage impedance equalizing resistor R283. Instantaneous changes in output current on the positive line reflect at the current summing point (terminal A7) and, hence, the base of Q300B. Stage Q300B varies its conduction in accordance with the polarity of the change at the summing point. The error voltage is taken from the collector Q300B and ultimately varies the conduction of the series regulator.

4-29 Resistor R301, in conjunction with C300, helps stabilize the feedback loop. Resistor R300 [illegible] the pullout resistor, serves as a [illegible] adjustment for the programming current flowing through R309 and R310.

4-31 GATING CIRCUIT

4-32 The gating circuit (see schematic) consists of gating amplifiers Q301 and Q300 and associated OR-gate diodes, CR300 and CR301. The gating circuit provides sharp crossover between constant voltage and constant current operation. During steady state conditions, one transistor is saturated while the other is conducting in its linear region. The cathodes of the OR-gate diodes are always at a more positive potential than the [illegible] potential of Q300 or Q301. Thus, the diode associated with the saturated transistor is reverse biased while the diode associated with the other transistor is forward biased. In the constant voltage mode Q301 is operating in its linear region and Q300 is saturated and so the positive collector voltage of Q300B. OR-gate diode CR301 is therefore reverse biased while OR-gate diode CR300 is forward biased, coupling the constant voltage feedback signal to the error amplifier. Opposite conditions prevail during constant current operation.

4-33 Capacitor C301 is a compensating capacitor which improves the [illegible] of the unit. Resistor R300 is the biasing resistor for the OR-gate diodes.

4-34 ERROR AMPLIFIERS

4-35 The error amplifiers Q311 and Q302 amplify the feedback signal from the constant voltage or constant current input circuit to a level sufficient to drive the series regulator transistor. Transistor Q[illegible] serves as the driver and Q302 the predriver for the series regulator. The RC network, composed of C311 and R307, is an equalizing network which provides for high frequency roll-off in the loop gain response in order to stabilize the feedback loop.

4-36 Capacitor C300, diode CR[illegible] and resistor R[illegible] form a long time constant network which [illegible] a slow turn-on characteristic. When the unit is first turned on, C[illegible] provides a positive voltage to the base of Q3[illegible] keeping the series regulator from conducting initially. As C[illegible] charges up, the restrictive bias becomes less positive enabling the regulator to turn on. Diode CR[illegible] provides a low resistance discharge path for C[illegible] when the unit is turned off.

4-37 FAULT INPUT CIRCUIT

4-38 The fault input circuit (see schematic) protects the power supply against overvoltage and overcurrent conditions. Transistor Q[illegible] and associated components comprise the overvoltage detector. With normal output voltage, Q[illegible] is cut off due to the [illegible] reference voltage connected to the top of voltage divider R[illegible] and R[illegible]. If the output voltage exceeds a certain limit (about 20% above the maximum rated output voltage), transistor Q[illegible] is driven into conduction. Current is then conducted away from the summing point and in opposition to the charge path of C[illegible] in the SCR control circuit. As a result, the SCR's are fired at a later time, reducing the series regulator input voltage to a safe value.

4-39 A full wave rectified voltage, obtained from the SCR control circuit, exercises a stabilizing influence on transistor Q[illegible]. This signal tends to synchronize the conduction of Q[illegible] at a 120 Hz rate preventing random firing of the SCR's.

4-40 Transistors Q[illegible] and Q[illegible] provide overcurrent and short circuit protection for the unit. Overcurrent protection is accomplished by Q[illegible] which is activated only if the constant current stage circuits should fail. Q[illegible] monitors the voltage drop across the current sampling resistor and conducts if this drop exceeds a certain level. The output of Q[illegible] is fed to gating amplifier Q[illegible] via R[illegible] and ultimately reduces the conduction of the series regulator.

4-41 Short circuit protection is provided by transistors Q[illegible] and Q[illegible]. Transistor Q[illegible], normally biased below cutoff, monitors the voltage drop across the series regulator. Under short circuit conditions, the increased voltage across the regulator drives Q[illegible] into saturation. The positive [illegible] voltage of Q[illegible] also drives Q[illegible] into conduction. The output of Q[illegible] limits the current flow through the series regulator to a prescribed level.

4-42 REFERENCE CIRCUIT (See Schematic at Rear)

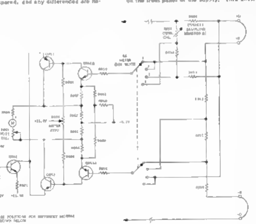
4-43 The reference circuit is a feedback power supply similar to the main supply. It provides stable reference voltages which are used throughout the unit. The reference voltages are all derived from smoothed dc obtained from the full wave rectifier (CR600 and CR601) and filter capacitor C600. The +9.4 and -6.2 voltages are developed across temperature compensated Zener diodes VR600 and VR601. Resistor R611 limits the current through the Zener diodes to establish an optimum bias level.

4-44 The regulating circuit consists of series regulating transistor Q600, error amplifier Q601, and differential amplifier Q602 and Q603. The voltage across the Zener reference diode VR600 and the voltage at the junction of divider R605 and R606 are compared, and any differences are detected by Q602 and Q603. The error voltage is amplified and inverted by Q601 and applied to series regulator Q600 in the correct phase and amplitude to maintain the +15.4 volt output constant.

4-45 Zener diode VR601 provides an additional bias voltage of -6.2 volts. Resistor R601, connected across Q600, minimizes power dissipation in the series element. Output capacitor C602 stabilizes the reference regulator loop.

4-46 METER CIRCUIT

4-47 The meter circuit (see Figure 4-8) provides continuous indications of output voltage or current on a single multiple range meter. The meter can be used either as a voltmeter or an ammeter depending upon the position of METER switch S2 on the front panel of the supply. This switch



NOTE:

S2 POSITIONS FOR DIFFERENT MODELS ARE SHOWN BELOW

MODEL	S2 TERMINAL NO.			
	1	2	3	4
[illegible]	1.2V	12V	[illegible]	1.2A
[illegible]	2.5V	25V	[illegible]	[illegible]
[illegible]	1.5V	25V	[illegible]	[illegible]
[illegible]	5V	50V	4A	4A
[illegible]	5V	50V	4A	4A
[illegible]	7V	70V	4A	4A

Figure 4-8. Meter Circuit, Simplified Schematic

ting in one of two meter ranges on each scale. The metering circuit consists basically of a selection circuit (switch S2 and associated voltage dividers), a stable differential amplifier stage (Q851A and Q851B), two meter amplifiers (Q852 and Q853), and the meter movement.

4-48 The selection circuit determines which voltage divider is connected to the differential amplifier input. When S2 is in one of the voltage positions, the voltage across divider R850, R851, and R852 (connected across the output of the supply) is the input to the differential amplifier. When S2 is in one of the current positions, the voltage across divider R853, R854, and R855 (connected across the sampling resistor) is the input to the differential amplifier. With S2 in the higher voltage range (position 2) the voltage drop across R852 is applied to stage Q851A while stage Q851B is grounded to the +S terminal. For low output voltages, S2 can be set to position (1) resulting in the application of a larger percentage of the output voltage (drop across R851 and R852) to stage Q851A. With S2 in the higher current position (3) the voltage drop across R853 is applied to stage Q851B while stage Q851A is grounded to the +S terminal. In the low current range, the voltage drop across R853 and R854 is applied to Q851B.

4-49 Differential amplifier stage Q851 is a stable device having a fixed gain of ten. To minimize temperature effects, the two stages are housed in a single package that is similar to those used in the constant voltage and current input circuits. The outputs of the differential amplifier drive meter amplifiers Q852 and Q853 which, in turn, deflect the meter. Transistor Q850 provides a constant bias current to the emitters of Q852 and Q853. Potentiometer R870 permits electrical zeroing of the meter.

4-50 The meter circuit contains an inherent current limiting feature which protects the meter movement against overloads. For example, if METER switch S2 is placed in the low current range when the power supply is actually delivering a higher ampere output, the differential amplifiers are quickly driven into saturation, limiting the current through the meter to a safe value.

5-1 INTRODUCTION

5-2 Upon receipt of the power supply, the performance check (Paragraph 5-10) should be made. This check is suitable for incoming inspection. If a fault is detected in the power supply while making the performance check or during normal operation, proceed to the troubleshooting procedures (Paragraph 5-28). After troubleshooting and repair (Paragraph 5-35), perform any necessary adjustments and calibrations (Paragraph 5-37). Before returning the power supply to normal operation, repeat the performance check to ensure that the fault has been properly corrected and that no other faults exist. Before doing any maintenance checks, turn-on power supply, allow a half-hour warm-up, and read the general information regarding measurement techniques (Paragraph 5-3).

5-3 GENERAL MEASUREMENT TECHNIQUES

5-4 The measuring device must be connected across the sensing leads of the supply or as close to the output terminals as possible when measuring the output impedance, transient response, regulation, or ripple of the power supply in order to achieve valid measurements. A measurement made across the load includes the impedance of the leads to the load and such lead lengths can easily have an impedance several orders of magnitude greater than the supply impedance, thus invalidating the measurement.

5-5 The monitoring device should be connected to the +S and -S terminals (see Figure 3-2) or as shown in Figure 5-1. The performance characteristics should never be measured on the front terminals if the load is connected across the rear terminals. Note that when measurements are made at the front terminals, the monitoring leads are connected at A, not B, as shown in Figure 5-1. Failure to connect the measuring device at A will result in a measurement that includes the resistance of the leads between the output terminals and the point of connection.

5-6 For output current measurements, the current sampling resistor should be a four-terminal resistor. The four terminals are connected as shown in Figure 5-2. In addition, the resistor should be of the low noise, low temperature coefficient (less than 30 ppm/°C) type and should be used at no more than 5% of its rated power so that its temperature rise will be minimized.

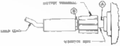


Figure 5-1 Front Panel Terminal Connections

Figure 5-2 Output Current Measurement Technique

5-7 When using an oscilloscope, ground one terminal of the power supply and then ground the case of the oscilloscope to this same point. Make certain that the case is not also grounded by some other means (power line). Connect both oscilloscope input leads to the power supply ground terminal and check that the oscilloscope is not exhibiting a ripple or transient due to ground loops, pick-up, or other means.

5-8 TEST EQUIPMENT REQUIRED

5-9 Table 5-1 lists the test equipment required to perform the various procedures described in this Section.

Table 5-1. Test Equipment Required

Type	Required Characteristics	Use	Recommended Model
Differential Voltmeter	Sensitivity: 1 mv full scale (min.). Input impedance: 10 megohms (min.).	Measure DC voltages, calibration procedures	HP 3420 (See Note)
Variable Voltage Transformer	Range: 90-130 volts. Equipped with voltmeter accurate within 1 volt	Vary AC input	----------------
AC Voltmeter	Accuracy: 2%. Sensitivity: 1 mv full scale deflection (min.)	Measure AC voltages and ripple	HP 403 B
Oscilloscope	Sensitivity: 100 µv/cm. Differential input.	Display transient response waveforms	HP 140 A plus 1400A plug in.
Oscillator	Range: 5Hz to 1 MHz. Accuracy: 2%.	Impedance checks	HP 200 CD
DC Voltmeter	Accuracy: 1%. Input resistance: 20,000 ohms/volt (min.)	Measure DC voltages	HP 412 A
Repetitive Load Switch	Rate: 60 — 400 Hz, 2µsec rise and fall time.	Measure transient response	See Figure 5-7
Resistive Loads	Value: See Paragraph 5-14, and Figure 5-6, ±5% 250 watts.	Power supply load resistors	----------------
Current Sampling Resistor	Value: See Figure 5-6, 1%, 200 watts, 20ppm, 4-Terminal	Measure current; calibrate meter	----------------
Resistor	1K, ±1% 2 watt non-inductive	Measure impedance	----------------
Resistor	100 ohms, ±5% 10 watt	Measure impedance	----------------
Resistor	Value: See Paragraph 5-45, 60 1%, 20 watt.	Calibrate programming current	----------------

Type	Required Characteristics	Use	Recommended Model
Resistor	Value: See Paragraph 5-47. ±0.1% 1/2 watt.	Calibrate programming current	----------------
Capacitor	500μf, 50 wvdc	Measure impedance.	----------------
Decade Resistance Box	Range: 0-500K. Accuracy: 0.1% plus 1 ohm Make-before-break contacts	Measure programming coefficients.	----------------

NOTE

A satisfactory substitute for a differential voltmeter is to arrange a reference voltage source and null detector as shown in Figure 5-3. The reference voltage source is adjusted so that the voltage difference between the supply being measured and the reference voltage will have the required resolution for the measurement being made. The voltage difference will be a function of the null detector that is used. Examples of satisfactory null detectors are: Ⓗ 419A null detector, a DC coupled oscilloscope utilizing differential input, or a 50 mv meter movement with a 100 division scale. For the latter, a 2 mv change in voltage will result in a meter deflection of four divisions.

CAUTION

Care must be exercised when using an electronic null detector in which one input terminal is grounded to avoid ground loops and circulating currents.

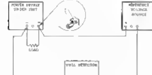


Figure 5-3. Differential Voltmeter Substitute, Test Setup

5-10 PERFORMANCE TEST

5-11 The following test can be used as an incoming inspection check and appropriate portions of the test can be repeated either to check the operation of the instrument after repairs or for periodic maintenance tests. The tests are performed using a 115-VAC 60 cps., single phase input power source. If the correct result is not obtained for a particular check, do not adjust any controls; proceed to troubleshooting (Paragraph 5-20).

5-12 CONSTANT VOLTAGE TESTS

5-13 Rated Output and Meter Accuracy.

5-14 Voltage. Proceed as follows

a. Connect load resistor across rear output terminals of supply. Resistor value to be as follows

Model	6282A	6285A	6286A	6290A	6291A	6296A
Res	1Ω	4Ω	2Ω	13Ω	8Ω	20Ω

b. Connect differential voltmeter across +S and -S terminals of supply observing correct polarity.

c. Set METER switch to highest voltage range and turn on supply.

d. Adjust VOLTAGE controls until front panel meter indicates exactly the maximum rated output voltage

e. Differential voltmeter should indicate maximum rated output voltage within ±2%.

5-15 Current. Proceed as follows

a. Connect test setup shown in Figure 5-4 leaving switch S1 open.

b. Turn CURRENT controls fully clockwise.

c. Set METER switch to highest current range and turn on supply

d. Adjust VOLTAGE controls until front panel meter indicates exactly the maximum rated output current

e. Differential voltmeter should read 1.0 ± 0.02 Vdc

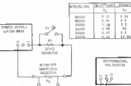


Figure 5-4 Output Current Test Setup

5-16 Load Regulation. To check constant voltage load regulation, proceed as follows

a. Connect test setup as shown in Figure 5-5

b. Turn CURRENT controls fully clockwise

c. Set METER switch to highest current range and turn on supply

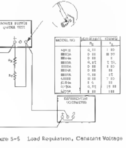


Figure 5-5 Load Regulation, Constant Voltage

d. Adjust VOLTAGE controls until front panel meter indicates exactly the maximum rated output voltage

e. Read and record voltage indicated on differential voltmeter

f. Disconnect load resistors

g. Reading on differential voltmeter should not vary from reading recorded in step e by more than the following (variations expressed in mVdc)

Model	6282A	6285A	6286A	6290A	6291A	6296A
Variation	±2	±3	±3	±5	±5	±7

NOTE

If measurements are made at the front terminals, readings will be 0.5mV per amp greater due to front terminal resistance.

5-17 Line Regulation. To check the line regulation, proceed as follows.

a. Connect variable auto transformer between input power source and power supply power input

b. Turn CURRENT controls fully clockwise

c. Connect test setup shown in Figure 5-5

d. Adjust variable auto transformer for 105 VAC input

e. Set METER switch to highest voltage range and turn on supply.

f. Adjust VOLTAGE controls until front panel meter indicates exactly the maximum rated output voltage

g. Read and record voltage indicated on differential voltmeter

h. Adjust variable auto transformer for 125 VAC input

i. Reading on differential voltmeter should not vary from reading recorded in step g by more than the following (variation) expressed in mVdc:

Model	6282A	6285A	6284A	6290A	6281A	6294A
Variation	±2	±3	±3	±5	±5	±7

5-18 Ripple and Noise. To check the ripple and noise, proceed as follows:

a. Retain test setup used for previous line regulation test except connect AC voltmeter across output terminals as shown in Figure 5-5.

b. Adjust variable auto transformer for 125 VAC input.

c. Set METER switch to highest current range.

d. Turn CURRENT controls fully clockwise and adjust VOLTAGE controls until front panel meter indicates exactly the maximum rated output voltage.

e. AC voltmeter should read less than 0.50mVrms.

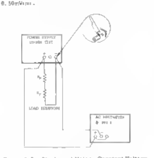


Figure 5-5. Ripple and Noise, Constant Voltage

5-19 Transient Recovery Time. To check the transient recovery time proceed as follows.

a. Connect test setup shown in Figure 5-7.

b. Turn CURRENT controls fully clockwise.

c. Set METER switch to highest current range and turn on supply.

d. Adjust VOLTAGE controls until front panel meter indicates exactly the maximum rated output current of 5 amperes, whichever is smaller.

e. Close line switch on repetitive load switch setup.

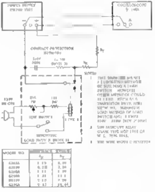


Figure 5-7. Transient Response, Test Setup

f. Adjust 25K potentiometer until a stable display is obtained on oscilloscope. Waveform should be within the tolerances shown in Figure 5-8 (output should return to within 15 mV of original value in less than 50 microseconds).

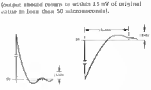


Figure 5-8 Transient Response Waveforms

5-20 Output Impedance. To check the output impedance, proceed as follows

a. Connect test setup shown in Figure 5-9.

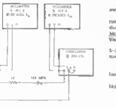


Figure 5-6 Output Impedance, Test Setup

e. Set METER switch to highest voltage range turn CURRENT controls fully clockwise, and turn on supply.

e. Adjust VOLTAGE controls until front panel meter reads 60 volts.

e. Set AMPLITUDE control on Oscillator to 10 volts (E_{in}) and FREQUENCY control to 100Hz.

e. Record voltage across output terminals of the power supply (E_o) as indicated on AC voltmeter.

f. Calculate the output impedance by the following formula.

$$Z_{out} = \frac{E_o R}{E_{in} - E_o}$$

E_o = is a voltage across power supply output terminals.

R = 1000

E_{in} = 60 volts

g. The output impedance (Z_{out}) should be less than 0.001 ohm.

h. Using formula of step f, calculate output impedance at frequencies of 6KHz, 600KHz, and 1MHz. Values should be less than 0.01 ohm, 0.6 ohm, and 2 ohms respectively.

5-20 CONSTANT CURRENT TESTS

5-20 Load Regulation. To check the constant current load regulation, proceed as follows.

a. Connect test setup shown in Figure 5-4.

b. Turn VOLTAGE controls fully clockwise.

c. Set METER switch to highest current range and turn on supply.

d. Adjust CURRENT controls until front panel meter reads exactly the maximum rated output current.

e. Read and record voltage indicated on differential voltmeter.

f. Short out load resistor (R_L) by closing switch S1.

g. Reading on differential voltmeter should not vary from reading recorded in step e by more than the following (variations expressed in mVdc):

Model	6282A	6285A	6284A	6290A	6001A	6286A
Variation	±0.50	±2.20	±0.60	±0.030	±0.70	±0.030

5-20 Line Regulation. To check the line regulation, proceed as follows.

a. Utilize test setup shown in Figure 5-4 leaving switch S1 open throughout test.

b. Connect variable auto transformer between input power source and power supply power input.

c. Adjust auto transformer for 105VAC input.

d. Turn VOLTAGE controls fully clockwise.

e. Set METER switch to highest current range and turn on supply.

f. Adjust CURRENT controls until front panel meter reads exactly the maximum rated output current.

g. Read and record voltage indicated on differential voltmeter.

h. Adjust variable auto transformer for 125 VAC input.

i. Reading on differential voltmeter should not vary from reading recorded in step g by more than the following (variations expressed in mVdc):

Model	6002A	6285A	6284A	6286A	6000A	6286A
Variation	±0.40	±2.10	±0.40	±0.030	±0.70	±0.030

5-20 Ripple and Noise. To check the ripple and noise, proceed as follows.

a. Use test setup shown in Figure 5-6 except connect AC voltmeter across sampling resistor instead of differential voltmeter.

b. Rotate VOLTAGE controls fully clockwise.

c. Set METER switch to highest current range and turn on supply.

d. Adjust CURRENT controls until front panel meter indicates exactly the maximum rated output current.

e. Turn range switch on AC voltmeter to 1mV position.

f. The AC voltmeter should read as follows. (Readings are expressed in mVac)

Model	6282A	6285A	6286A	6290A	6201A	6286A
Reading	0.50	0.60	0.50	0.0	0.0	1.0

5-20 TROUBLESHOOTING

5-20 Components within Hewlett-Packard power supplies are conservatively operated to provide maximum reliability. In spite of this, parts within a supply may fail. Usually the instrument must be immediately repaired with a minimum of "down time" and a systematic approach as outlined in succeeding paragraphs can greatly simplify and speed up the repair.

5-27 TROUBLE ANALYSIS

5-28 General. Before attempting to trouble shoot this instrument, ensure that the fault is with the instrument and not with an associated circuit. The performance test (Paragraph 5-10) enables this to be determined without having to remove the instrument from the cabinet.

5-29 Once it is determined that the power supply is at fault, check for obvious troubles such as open fuse, a defective power cable, or an input power failure. Next, remove the top and bottom covers (each held by four retaining screws) and inspect for open connections, charred components, etc. If the trouble source cannot be detected by visual inspection, follow the detailed procedure outlined in succeeding paragraphs. Once the defective component has been located (by means of visual inspection or trouble analysis) correct it and re-conduct the performance test. If a component is replaced, refer to the repair and replacement and adjustment and calibration paragraphs in this section.

5-30 A good understanding of the principles of operation is a helpful aid in troubleshooting, and it is recommended that the reader review Section IV of the manual before attempting to troubleshoot the unit in detail. Once the principles of operation are understood, logical application of this knowledge used in conjunction with the normal voltage readings and waveforms shown on the schematic and the additional procedures given in the following paragraphs should suffice to isolate a fault to a component or small group of components. The component location diagram at the rear of the manual can be consulted to determine the location of components and test points. The normal voltages shown on the schematic are positioned adjacent to the applicable test points (identified by encircled numbers on the schematic and component location diagram). Additional test procedures that will aid in isolating troubles are as follows:

a. Reference circuit check (Paragraph 5-31). This circuit provides critical operating voltages for the supply and faults in the circuit could affect the overall operation in many ways. This circuit should be checked first, before proceeding to other areas of the unit.

b. Series regulator and preregulator feedback loop checks (Paragraph 5-32).

c. Procedures for dealing with common troubles (Paragraph 5-33).

5-31 Reference Circuit.

a. Make an ohmmeter check to be certain that neither the positive nor negative output terminal is grounded.

b. Turn front panel VOLTAGE and CURRENT controls fully clockwise (maximum).

c. Turn on power supply (no load connected).

d. Proceed as instructed in Table 5-2.

5-32 Series Regulator and Preregulator Feedback Circuits. Generally, malfunction of these two feedback circuits is indicated by high or low (or no) output voltage. If one of these situations occur disconnect the load and proceed as instructed in Table 5-3 or 5-4. Preregulator waveforms are included on the schematic at the rear of the manual.

5-33 Common Troubles. Table 5-5 lists the symptoms, checks, and probable causes for common troubles.

5-34 REPAIR AND REPLACEMENT

5-35 Before servicing a printed wiring board refer to Figure 5-10. Section VI of this manual contains a list of replaceable parts. Before replacing a semiconductor device, refer to Table 5-7 which lists the special characteristics of selected semiconductors. If the device to be replaced is not listed in Table 5-7, the standard manufacturers part number listed in Section VI is applicable. After replacing a semiconductor device, refer to Table 5-8 for checks and adjustments that may be necessary.

Table 5-2. Reference Circuit Troubleshooting

Step	Meter Common	Meter Positive	Normal Indication	If Indication Abnormal, Take This Action
1	+S	29	9.0 ±0.4Vdc	Check 15.0 volt bias or VR600
2	28	+S	6.0 ±0.3Vdc	Check diode VR601
3	+S	30	15.0 ±0.5Vdc	Check R605, Q600 through Q603, C600, C600, and CR601.

Table 5-3 High Output Voltage Troubleshooting

Step	Measure	Response	Probable Cause
1	Voltage between TP20 and TP90	a. 0V or negative	a. Q400 (Q401) shorted C0400 shorted
		b. More positive than 0V	b. Q303 open or 0209 shorted Proceed to Step 2
2	Voltage between +S and A4	a. 0V to +0.8V	a. Open strap A2—A4 R812 or R814 open R805 or R808 shorted
		b. More negative than 0V	b. Proceed to Step 5
3	Voltage between +S and 11	a. More positive than +1.5V	a. Q100B shorted Q100A open
		b. +0.9V to +1.5V	b. Proceed to Step 4
4	Voltage between +S and 21	a. More negative than 0V	a. Q302 open Q201 open 0305, 0300 shorted

Table 5-4. Low Output Voltage Troubleshooting

Step	Measure	Response	Probable Cause
1	Voltage between TP25 and TP90	a. More positive than 0V	a. Proceed to Step 2
		b. 0V or negative	b. Proceed to Step 3
2	Voltage between TP90 and TP27	a. Less positive than +4V	a. Check fuse F1. If blown check C0502 or CR504 for short. If not blown, proceed to Table 5-5
		b. More positive than +5V	b. Q400 (Q401) open Proceed to Step 3
3	Disable Q200 by disconnecting C0200	a. Normal output voltage	a. Constant Current circuit faulty; check Q200B, R810, R805, for short
		b. Low output voltage	b. If supply is furnishing current without load, check CR805, C802, or C803 for short. If it is not, proceed to Step 3
4	Voltage between +S and A4	a. More negative than 0V	a. Open strap A4—A5 R812, R814, C801 Proceed to Step 5

Table 5-4. Low Output Voltage Troubleshooting (Continued)

Step	Measure	Response	Probable Cause
5	Voltage between +S and 11	a. Less positive than +0.9V	a. Q100B open Q100A shorted Q302 or Q301 shorted
		b. +0.9V to +1.5V	b. Proceed to Step 6
6	Voltage between +S and 21	a. 0V or positive	a. Q301 shorted Q302 shorted R310 shorted

Table 5-5. Preregulator/Control Circuit Troubleshooting

Step	Measure	Response	Probable Cause
1	Waveform between 4 and 3 of T700	a. Normal firing pulse	a. CR502-CR504 defective R501-R502 open CR501, CR503, T600 defective
		b. No or abnormal firing pulse	b. T700 open CR500 shorted Proceed to Step 2
2	Waveform between 90 and 47	a. Zero or small positive voltage	a. Q700 shorted C701 shorted Q701 open R703, primary T700 open Proceed to Step 3
		b. +18 to +28 Volt level	b. Q700 open R703 shorted Q701 shorted Proceed to Step 3
		c. Waveform distorted	c. Proceed to Step 3
3	Waveform between 90 and 58	a. Amplitude incorrect	a. Q702 defective R707, R708, R713 incorrect value or open C700, CR710, C711 defective
		b. Period incorrect	b. CR708 defective Proceed to Step 4
4	Waveform between 90 and 52	a. Amplitude incorrect	a. CR708, CR708, R702 defective
		b. Period incorrect	b. CR700 through CR703 defective
5	Waveform between 90 and 54	a. Amplitude incorrect	a. R700, R701, C701 defective
		b. Period incorrect	b. CR704 through CR707 defective

Table 5-6. Common Troubles

Symptom	Checks and Probable Causes
High ripple	a. Check operating setup for ground loops. b. If output floating, connect 1 µf capacitor between output and ground. c. Ensure that supply is not crossing over to constant current mode under loaded conditions d. Check for low voltage across C[illegible] or Q[illegible] e. Check for excessive ripple on reference voltages. Peak-to-peak ripple should be less than 3mV for +9.4V and -6.2V and less than 4mV for +15.4V.
Poor line regulation	a. Check reference circuit (Paragraph 5-51).
Poor load regulation (Constant Voltage)	a. Measurement technique. (Paragraph [illegible].) b. Check reference circuit (Paragraph 5-31). c. Ensure that supply is not going into current limit. Check constant current input circuit.
Poor load regulation (Constant Current)	a. Check reference circuit (Paragraph 5-31). b. C802, C803, and C[illegible] leaky. c. Ensure that supply is not crossing over to constant voltage operation. Check constant voltage input circuit.
Oscillates (Constant Voltage / Constant Current)	a. Check C501 for open, adjustment of R[illegible] (Paragraph 5-[illegible]). b. Check R103, C100 or R304, C[illegible].
Poor Stability (Constant Voltage)	a. Check reference voltages (Paragraph 5-31). b. Noisy programming resistors R[illegible], R[illegible] c. CR100 CR101 leaky. d. Check R100, R[illegible], R[illegible], C[illegible] for noise or drift e. Stage Q100 defective.
Poor Stability (Constant Current)	a. Check reference voltages (Paragraph 5-31). b. Noisy programming resistors R[illegible], R[illegible]. c. C[illegible] C[illegible], C[illegible] leaky. d. Check R[illegible], R[illegible], R200, R[illegible], for noise or drift e. Stage Q200 defective

Table 5-7. Selected Semiconductor Characteristics

Reference Designator	Characteristics	Stock No.	Suggested Replacement
Q100 Q200	Matched differential amplifier. NPN Si Planar. [illegible] (min.) h_{FE} @ I_C = 1 mA, V_{CE} = [illegible]V. I_{CO} 0.[illegible] µa @ V_{CBO} = [illegible]V.	1854-0229	2N2917 G.E.
Q303 Q400 (Q401)	NPN Power. h_{FE} = 35 (min) @ I_C = 4A, V_{CE} = 4V	1854-0225	2N30[illegible] R.C.A.
Q[illegible]51	Matched differential amplifier, NPN Si	1854-0221	2N4045 Union Carbide

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties.

A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

When replacing components with multiple mounting pins such as valve sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

WARNING: If the specific instructions outlined in the steps below regarding etched circuit boards without eyelets are not followed, extensive damage to the etched circuit board will result.

1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component does not pass through an eyelet, apply heat to conductor side of board.

2. Reheat solder in circuit eyelet and quickly insert a small awl to clean mouth of hole. If hole does not have an eyelet, insert awl or a #57 drill from conductor side of board.

3. Bend clean tinned lead on new part and carefully insert through eyelets or holes in board.

4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.

In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

1. Clip lead as shown below.

2. Bend protruding leads upward. Bend lead of new component around protruding lead. Apply solder using a pair of long nose pliers as a heat sink.

This procedure is used in the field only as an alternate means of repair. It is not used within the factory.

Figure 5-2b Servicing Printed Wiring Boards

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties.

A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

WARNING: If the specific instructions outlined in the steps below regarding etched circuit boards without eyelets are not followed, extensive damage to the etched circuit board will result.

1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component does not pass through an eyelet, apply heat to conductor side of board.

2. Reheat solder in vacant eyelet and quickly insert a small awl to clean inside of hole. If hole does not have an eyelet, insert awl or a #57 drill from conductor side of board.

3. Bend clean tinned leads on new part and carefully insert through eyelets or holes in board.

4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.

In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

1. Clip lead as shown below.

2. Bend protruding leads upward. Bend lead of new component around protruding lead. Apply solder using a pair of long nose pliers as a heat sink.

This procedure is used in the field only as an alternate means of repair. It is not used within the factory.

Figure 5-8b Servicing Printed Wiring Boards

Table 5-8. Checks and Adjustments After Replacement of Semiconductor Devices (Continued)

CR600, CR601, CR800, CR801, CR501–CR504	Rectifier diodes	Voltage across appropriate filter capacitor	
VR600, VR601	Reference voltages	Check +9.4V and –6.2V reference voltages	

Table 5-9. Calibration Adjustment Summary

Adjustment or Calibration	Paragraph	Control Device
Meter Zero	5-38	Pointer
Voltmeter Tracking	5-40	R870 and R865
Ammeter Tracking	5-42	R855
"Voltage" Programming Current	5-44	R806
"Current" Programming Current	5-46	R808
Overvoltage Trip	5-48	R604
Transient Response	5-50	R307
Preregulator Tracking	5-52	R711

5-36 ADJUSTMENT AND CALIBRATION

5-37 Adjustment and calibration may be required after performance testing, troubleshooting, or repair and replacement. Perform only those adjustments that affect the operation of the faulty circuit and no others. Table 5-9 summarizes the adjustments and calibrations contained in the following paragraphs.

5-38 METER ZERO

5-39 Proceed as follows to zero meter:

a. Turn off instrument (after it has reached normal operating temperature) and allow 30 seconds for all capacitors to discharge.

b. Insert sharp pointed object (pen point or awl) into the small indentation near top of round black plastic disc located directly below meter face.

c. Rotate plastic disc clockwise (cw) until meter reads zero, then rotate ccw slightly in order to free adjustment screw from meter suspension. If pointer moves, repeat steps b and c.

5-40 VOLTMETER TRACKING

5-41 To calibrate voltmeter tracking, proceed as follows:

a. To electrically zero meter, set METER switch to highest current position and, with supply off and no load connected, adjust R870 until front panel meter reads zero.

b. Connect differential voltmeter across supply, observing correct polarity.

c. Set METER switch to highest voltage range and turn on supply. Adjust VOLTAGE control until differential voltmeter reads exactly the maximum rated output voltage.

d. Adjust R865 until front panel meter also indicates maximum rated output voltage.

5-42 AMMETER TRACKING

5-43 To calibrate ammeter tracking, proceed as follows:

a. Zero meter as described in step a of 5-41. Connect test setup shown on Figure 5-4 leaving switch S1 open.

b. Turn VOLTAGE control fully clockwise and set METER switch to highest current range.

c. Turn on supply and adjust CURRENT controls until differential voltmeter reads 1.0Vdc.

d. Adjust R855 until front panel meter indicates exactly the maximum rated output current.

5-44 CONSTANT VOLTAGE PROGRAMMING CURRENT

5-45 To calibrate the constant voltage programming current, proceed as follows:

a. Connect a 0.1%, 20 watt resistor between terminals -S and A4 on rear barrier strip. Resistor value to be as follows.

Model	6282A	6285A	6286A	6290A	6291A	6296A
Res	7K	4K	[illegible]	8K	[illegible]	18K

b. Disconnect jumper between A3 and A4 on rear terminal barrier strip.

c. Connect a decade resistance in place of R806.

d. Connect a differential voltmeter between +S and -S and turn on supply.

e. Adjust decade resistance box so that differential voltmeter indicates maximum rated output voltage within the following tolerances:

Model	6282A	6285A	6286A	6290A	6291A	6296A
Tol (Vdc)	±0.2	±0.4	±0.4	±0.8	±0.8	±1.7

f. Replace decade resistance with resistor of appropriate value in R806 position.

5-46 CONSTANT CURRENT PROGRAMMING CURRENT

5-47 To calibrate the constant current programming current, proceed as follows:

a. Connect power supply as shown in Fig. 5-4.

b. Remove strap between A8 and A7 (leaving A7 and A8 jumpered).

c. Connect a 0.1% 1/2 watt resistor between A1 and A2. Resistor value is 1KΩ (1.5KΩ for Models 6290A and 6296A).

d. Connect decade resistance box in place of R800.

e. Set METER switch to highest current range and turn on supply.

f. Adjust the decade resistance so that the differential voltmeter indicates 1.0 ± [illegible]2Vdc.

g. Replace decade resistance with appropriate value resistor in R808 position.

5-48 OVERVOLTAGE TRIP

5-49 To adjust the overvoltage trip point, proceed as follows:

a. Connect differential voltmeter across +S and -S terminals of supply.

b. Rotate VOLTAGE controls fully clockwise.

c. Turn on unit. Differential voltmeter should read 20% above maximum rated output voltage within ±5%.

d. If it does not, turn off supply and connect decade resistance across R605 in place of R604.

e. Adjust decade resistance until differential voltmeter reads that indicated in step c.

NOTE

The +6.4V reference voltage must be kept within ±0.1Vdc when adjusting the decade resistance box.

f. Replace decade resistance with resistor of appropriate value in R604 position.

5-50 TRANSIENT RECOVERY TIME

5-51 To adjust the transient response, proceed as follows:

a. Connect test setup as shown in Figure 5-7.

b. Repeat steps a through e as outlined in Paragraph 5-19.

c. Adjust R307 so that the transient response is as shown in Figure 5-8.

5-52 PREREGULATOR TRACKING (60Hz OPERATION)

5-53 To adjust the preregulator control circuit with a 60Hz ac input, proceed as follows:

a. Connect proper load resistor across output terminals of supply. Resistance value to be as follows:

Model	6282A	6285A	6286A	6290A	6291A	6296A
Res	1Ω	4Ω	2Ω	13Ω	8Ω	28Ω

b. Connect DC voltmeter between TP27 and TP90 (across series regulator).

c. Turn on supply and adjust VOLTAGE controls for maximum rated output voltage.

d. Adjust R211 so that DC voltmeter reads 3 ± 0.2Vdc.

5-54 PREREGULATOR TRACKING (50Hz OPERATION)

5-55 To adjust the preregulator control circuit when the ac input is from a 50Hz source, proceed as follows:

a. Connect load resistor across rear output terminals of supply. Resistor value to be as follows:

Model	6282A	6285A	6286A	6290A	6291A	6296A
Res	1Ω	4Ω	2Ω	13Ω	8Ω	28Ω

b. Connect oscilloscope (dc coupled) across series regulator, T.P. 27 to T.P. 90.

c. Disconnect R709 in the SCR control circuit and connect decade resistance box in its place.

d. Rotate CURRENT controls fully clockwise and turn on supply.

e. Decrease resistance of decade resistance from normal value of R709 until sawtooth waveform on oscilloscope is symmetrical (amplitude of 50Hz sawtooth waveforms equal).

f. Replace decade resistance box with appropriate value resistor in R709 position.

g. Adjust ramp potentiometer R711 for 3.5Vdc drop across series regulator.

h. If 3.5 volts cannot be obtained, remove R712 (in series with R711) and connect the decade resistance box in its place.

i. Increase value of decade resistance box from normal value of R712 until 3.5Vdc drop is obtained across series regulator.

j. Remove decade resistance and connect new resistance value in R712 position.

SECTION VI
REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering replacement parts. Table 6-4 lists parts in alphanumeric order by reference designators and provides the following information:

a. Reference Designators. Refer to Table 6-1.

b. Description. Refer to Table 6-2 for abbreviations.

c. Total Quantity (TQ). Given only the first time the part number is listed except in instruments containing many sub-modular assemblies, in which case the TQ appears the first time the part number is listed in each assembly.

d. Manufacturer's Part Number or Type.

e. Manufacturer's Federal Supply Code Number. Refer to Table 6-3 for manufacturer's name and address.

f. Hewlett-Packard Part Number.

g. Recommended Spare Parts Quantity (RS) for complete maintenance of one instrument during one year of isolated service.

h. Parts not identified by a reference designator are listed at the end of Table 6-4 under Mechanical and/or Miscellaneous. The former consists of parts belonging to and grouped by individual assemblies; the latter consists of all parts not immediately associated with an assembly.

6-3 ORDERING INFORMATION

6-4 To order a replacement part, address order or inquiry to your local Hewlett-Packard sales office (see lists at rear of this manual for addresses). Specify the following information for each part: Model, complete serial number, and any Option or special modification (J) numbers of the instrument; Hewlett-Packard part number; circuit reference designator; and description. To order a part not listed in Table 6-4, give a complete description of the part, its function, and its location.

Table 6-1. Reference Designators

A	= assembly	E	= miscellaneous electronic part
B	= blower (fan)	F	= fuse
C	= capacitor	J	= jack, jumper
CB	= circuit breaker	K	= relay
CR	= diode	L	= inductor
DS	= device, signaling (lamp)	M	= meter

Table 6-1. Reference Designators (Continued)

P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
Q	= transistor	VR	= zener diode
R	= resistor	X	= socket
S	= switch	Z	= integrated circuit or network
T	= transformer		
TB	= terminal block		
TS	= thermal switch		

Table 6-2. Description Abbreviations

A	= ampere	mfr	= manufacturer
ac	= alternating current	mod.	= modulator or modified
assy.	= assembly	mtg	= mounting
bd	= board	n	= nano = 10^{-9}
bkt	= bracket	NC	= normally closed
°C	= degree Centigrade	NO	= normally open
cd	= card	NP	= nickel-plated
coef	= coefficient	Ω	= ohm
comp	= composition	obd	= order by description
CRT	= cathode-ray tube	OD	= outside diameter
CT	= center-tapped	p	= pico = 10^{-12}
dc	= direct current	P C	= printed circuit
DPDT	= double pole, double throw	pot.	= potentiometer
DPST	= double pole, single throw	p-p	= peak-to-peak
elect	= electrolytic	ppm	= parts per million
encap	= encapsulated	pvr	= peak reverse voltage
F	= farad	rect	= rectifier
°F	= degree Farenheit	rms	= root mean square
fxd	= fixed	Si	= silicon
Ge	= germanium	SPDT	= single pole, double throw
H	= Henry	SPST	= single pole, single throw
Hz	= Hertz	SS	= small signal
IC	= integrated circuit	T	= slow-blow
ID	= inside diameter	tan.	= tantalum
incand	= incandescent	Ti	= titanium
k	= kilo = 10^3	V	= volt
m	= milli = 10^{-3}	var	= variable
M	= mega = 10^6	ww	= wirewound
μ	= micro = 10^{-6}	W	= Watt
met.	= metal		

Table 6-3. Code List of Manufacturers

CODE NO.	MANUFACTURER	ADDRESS
00611	EBY Sales Co Inc	Jamaica, N.Y.
00656	Aerovox Corp.	New Bedford, Mass.
00853	Sangamo Electric Co S. Carolina Div.	Pickens, S.C.
01121	Allen Bradley Co	Milwaukee, Wis.
01255	Litton Industries, Inc	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc	Lawndale, Calif
01295	Texas Instruments, Inc Semiconductor-Components Div	Dallas, Texas
01686	RCL Electronics, Inc	Manchester, N.H.
01930	Amerock Corp	Rockford, Ill.
01961	Sparta Mfg. Co.	Dover, Ohio
02114	Ferroxcube Corp	Saugerties, N.Y.
02606	Fenwal Laboratories	Morton Grove, Ill.
02660	Amphenol Corp	Broadview, Ill.
02735	Radio Corp. of America, Solid State and Receiving Tube Div	Somerville, N.J.
03508	G.E. Semiconductor Products Dept	Syracuse, N.Y.
03797	Eldema Corp	Compton, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co, Inc	Cedar Knolls, N.J.
04009	Arrow Hart and Hegeman Electric Co.	Hartford, Conn.
04072	ADC Electronics Inc	Harbor City, Calif
04213	Caddell & Burns Mfg. Co, Inc	Mineola, N.J.
04404	*Hewlett-Packard Co. Palo Alto Div.	Palo Alto, Calif.
04713	Motorola Semiconductor Prod. Inc	Phoenix, Arizona
05277	Westinghouse Electric Corp Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix Inc	Grand Junction, Colo.
05820	Wakefield Engr Inc	Wakefield, Mass.
06001	General Elect. Co Electronic Capacitor & Battery Dept	Irmo, S.C.
06004	Bassik Div Stewart-Warner Corp.	Bridgeport, Conn.
06486	IRC Div. of TRW Inc. Semiconductor Plant	Lynn, Mass.
06540	Amatom Electronic Hardware Co. Inc	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co.	Penacook, N.H.
06666	General Devices Co Inc	Indianapolis, Ind.
06751	Semcor Div Components, Inc.	Phoenix, Arizona
06776	Robinson Nugent, Inc.	New Albany, Ind.
06812	Torrington Mfg Co., West Div	Van Nuys, Calif.
07131	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div	Elmira, N.Y.
07263	Fairchild Camera and Instrument Corp. Semiconductor Div.	Mountain View, Calif
07387	Birtcher Corp., The	Los Angeles, Calif
07397	Sylvania Electric Prod. Inc. Sylvania Electronic Systems Western Div	Mountain View, Calif
07716	IRC Div. of TRW Inc., Burlington Plant	Burlington, Iowa
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Co. Components Div Semiconductor Operation	Mountain View, Calif
08484	Breeze Corporations Inc.	Union, N.J.
08530	Reliance Mica Corp.	Brooklyn, N.Y.
08717	Sloan Company, The	Sun Valley, Calif
08730	Vemaline Products Co, Inc	Wyckoff, N.J.
08806	General Elect. Co. Miniature Lamp Dept.	Cleveland, Ohio
08863	Nylomatic Corp.	Norrisville, Pa.
08919	RCH Supply Co.	Vernon, Calif
09021	Airco Speer Electronic Components	Bradford, Pa.
09182	*Hewlett-Packard Co. New Jersey Div	Berkeley Heights, N.J.
09213	General Elect. Co. Semiconductor Prod. Dept.	Buffalo, N.Y.
09214	General Elect. Co. Semiconductor Prod. Dept.	Auburn, N.Y.
09353	C & K Components Inc.	Newton, Mass.
09922	Burndy Corp.	Norwalk, Conn.
11115	Wagner Electric Corp. Tung-Sol Div.	Bloomfield, N.J.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of Cal. Inc	So. Pasadena, Calif.
11502	IRC Div. of TRW Inc. Boone Plant	Boone, N.C.
11711	General Instrument Corp Rectifier Div	Newark, N.J.
12136	Philadelphia Handle Co. Inc	Camden, N.J.
12615	U.S. Terminals, Inc.	Cincinnati, Ohio
12617	Hamlin Inc	Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Inc.	Dover, N.H.
13103	Thermalloy Co.	Dallas, Texas
14493	*Hewlett-Packard Co. Loveland Div	Loveland, Colo.
14655	Cornell-Dubilier Electronics Div Federal Pacific Electric Co.	Newark, N.J.
14936	General Instrument Corp. Semiconductor Prod. Group	Hicksville, N.Y.
15801	Fenwal Elect.	Framingham, Mass.
16299	Corning Glass Works, Electronic Components Div	Raleigh, N.C.

*Use Code 28480 assigned to Hewlett-Packard Co., Palo Alto, California

Table 6-3. Code List of Manufacturers (Continued)

CODE NO.	MANUFACTURER	ADDRESS
16758	Delco Radio Div. of General Motors Corp.	Kokomo, Ind.
1[illegible]545	Atlantic Semiconductors, Inc.	Asbury Park, N.J.
[illegible]803	Fairchild Camera and Instrument Corp. Semiconductor Div. Transducer Plant	Mountain View, Calif.
1[illegible]920	Devar Div. Thomas A. Edison Industries McGraw-Edison Co.	Orange, N.J.
18[illegible]2[illegible]	Signetics Corp.	Sunnyvale, Calif.
[illegible]	Bendix Corp. The Navigation and Control Div.	Teterboro, N.J.
[illegible]97[illegible]	Electra/Midland Corp.	Mineral Wells, Texas
2[illegible]52[illegible]	Fansteel Metallurgical Corp.	No. Chicago, Ill.
22229	Union Carbide Corp. Electronics Div.	Mountain View, Calif.
[illegible]	UID Electronics Corp.	Hollywood, Fla.
23[illegible]36	Pamotor, Inc.	Tampa, Texas
[illegible]546	General Electric Co.	Schenectady, N.Y.
2[illegible]53	General Electric Co. Lamp Div. of Consumer Prod. Group	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
[illegible]	LTV Electrosystems Inc. Memcor/Components Operations	Huntington, Ind.
[illegible]9[illegible]	Dynacool Mfg. Co. Inc.	Saugerties, N.Y.
27014	National Semiconductor Corp.	Santa Clara, Calif.
[illegible]8[illegible]	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
[illegible]	DdC Magnetics Corp. New Hampshire Div.	Rochester, N.H.
[illegible]4	SAE Advance Packaging, Inc.	Santa Ana, Calif.
3161[illegible]	Budwig Mfg. Co.	Ramona, Calif.
[illegible]	G. E. Co. Tube Dept.	Owensboro, Ky.
35434	Lectrohm, Inc.	Chicago, Ill.
[illegible]	P. R. Mallory & Co. Inc.	Indianapolis, Ind.
[illegible]2190	Muter Co.	Chicago, Ill.
43334	New Departure-Hyatt Bearings Div. General Motors Corp.	Sandusky, Ohio
[illegible]555	Ohmite Manufacturing Co.	Skokie, Ill.
[illegible]	Penn Engr. and Mfg. Corp.	Doylestown, Pa.
[illegible]804	Polaroid Corp.	Cambridge, Mass.
49956	Raytheon Co.	Lexington, Mass.
[illegible]5[illegible]	Simpson Electric Co. Div. of American Gage and Machine Co.	Chicago, Ill.
[illegible]	Sprague Electric Co.	North Adams, Mass.
58474	Superior Electric Co.	Bristol, Conn.
[illegible]84[illegible]	Syntron Div. of FMC Corp.	Homer City, Pa.
59730	Thomas and Betts Co.	Philadelphia, Pa.
[illegible]63[illegible]	Union Carbide Corp.	New York, N.Y.
[illegible]2	Ward Leonard Electric Co.	Mt. Vernon, N.Y.

CODE NO.	MANUFACTURER	ADDRESS
7056[illegible]	Amperite Co., Inc.	Union City, N.J.
70931?	[illegible] Bearing Co.	Fort Washington, Pa.
70903	Belden Corp.	Chicago, Ill.
[illegible]121[illegible]	Bud Radio, Inc.	Willoughby, Ohio
[illegible]2[illegible]	Cambridge Thermionic Corp.	Cambridge, Mass.
[illegible]400	Bussmann Mfg. Div. of McGraw & Edison Co.	St. Louis, Mo.
[illegible]45[illegible]	CTS Corp.	Elkhart, Ind.
71468	I.T.T. Cannon Electric Inc.	Los Angeles, Calif.
71590	Globe-Union Inc. Centralab Div.	Milwaukee, Wis.
71700	General Cable Corp. Cornish Wire Co. Div.	Williamstown, Mass.
71[illegible]	Coto Coil Co., Inc.	Providence, R.I.
*717[illegible]	Chicago Miniature Lamp Works	Chicago, Ill.
71[illegible]85	Cinch Mfg. Co. and Howard B. Jones Div.	Chicago, Ill.
[illegible]1984	Dow Corning Corp.	Midland, Mich.
[illegible]2136	Electro Motive Mfg. Co. Inc.	Willimantic, Conn.
[illegible]26[illegible]	Dialight Corp.	Brooklyn, N.Y.
[illegible]2699	General Instrument Corp.	Newark, N.J.
[illegible]2765	Drake Mfg. Co.	Harwood Heights, Ill.
72962	Elastic Stop Nut Div. of Amerace Esna Corp.	Union, N.J.
72982	Erie Technological Products Inc.	Erie, Pa.
73096	Hart Mfg. Co.	Hartford, Conn.
73136	Beckman Instruments Inc. Helipot Div.	Fullerton, Calif.
[illegible]3168	Fenwal, Inc.	Ashland, Mass.
*3293	Hughes Aircraft Co. Electron Dynamics Div.	Torrance, Calif.
[illegible]3445	Amperex Electronic Corp.	Hicksville, N.Y.
[illegible]3586	Bradley Semiconductor Corp.	New Haven, Conn.
[illegible]3559	Carling Electric, Inc.	Hartford, Conn.
73734	Federal Screw Products, Inc.	Chicago, Ill.
[illegible]4193	Heinemann Electric Co.	Trenton, N.J.
[illegible]4545	Hubbell Harvey Inc.	Bridgeport, Conn.
74868	Amphenol Corp. Amphenol RF Div.	Danbury, Conn.
[illegible]4970	E. F. Johnson Co.	Waseca, Minn.
75042	IRC Div. of TRW Inc.	Philadelphia, Pa.
*5183	*Howard B. Jones Div. of Cinch Mfg. Corp.	New York, N.Y.
75376	Kurz and Kasch, Inc.	Dayton, Ohio
[illegible]5382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75915	Littelfuse, Inc.	Des Plaines, Ill.
7638[illegible]	Minnesota Mining and Mfg. Co.	St. Paul, Minn.
76385	Minor Rubber Co. Inc.	Bloomfield, N.J.
76487	James Millen Mfg. Co. Inc.	Malden, Mass.
76493	J. W. Miller Co.	Compton, Calif.

*Use Code 71785 assigned to Cinch Mfg. Co., Chicago, Ill.

Table 6-3 Code List of Manufacturers (Continued)

CODE NO	MANUFACTURER	ADDRESS
73533	Cinel	City of Industry Calif
16311	Cal Mfg Co, Div of Cal Electro/Nallon Corp	Crystal Lake, Ill
77066	Bendix Corp. Electrodynamics Div	No. Hollywood Calif
11131	Fabart Co.	Masonside N J
11111	Raman-MacGayne Co.	Providence, R.I
11221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif
11311	Philadelphia Steel and Wire Corp	Philadelphia, Pa.
17342	American Machine and Foundry Co. Potter and Brumfield Div	Princeton Ind.
11130	TRW Electronic Components Div	Camden, N J
31114	Resistance Products Co.	Harrisburg Pa
18189	Illinois Tool Works Inc Shakeproof Div	Elgin Ill
16152	Dualoc Chicago Inc.	Chicago Ill
16411	Stackpole Carbon Co.	St. Marys Pa.
16521	Stanwyck Winding Div, San Fernando Electric Mfg Co, Inc	Newburgh, N Y
13113	Timmerman Products, Inc	Cleveland, Ohio
11531	Stewart Stamping Corp	Yonkers N Y
31116	Walden Kohinoor Inc	L.I.C N Y.
18907	Whitehead Metals Inc	New York N Y
11127	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
13963	Ziedel Mfg. Co.	Mt. Kisco N Y
13031	Melco Div. of Sessions Clock Co	Morristown, N J
10294	Bourns Inc	Riverside Calif
31043	Howard Industries Div of Mel Ind. Inc	Racine Wisc
11013	Grayhill, Inc	La Grange Ill
81483	International Rectifier Corp.	El Segundo, Calif
81111	Columbus Electronics Corp	Yonkers, N Y
83633	Goodyear Laundries & Mechanical Co Inc	New York, N Y.
83111	Airco Speer Electronic Components	Du Bois, Pa.
13319	Sylvania Electric Products Inc Electronic Tube Div Receiving Tube Operations	Emporium, Pa
82111	Switchcraft, Inc	Chicago Ill
82613	Metals and Controls Inc Control Products Group	Attleboro, Mass
82866	Research Products Corp	Madison, Wis
83111	Rotron Inc	Woodstock, N Y
83883	Vector Electronic Co.	Glendale Calif
83113	Carr Fastener Co	Cambridge Mass
83136	Victory Engineering Corp	Springfield N.J.
13298	Bendix Corp Electric Power Div	Eatontown N J
13330	Herman H Smith, Inc	Brooklyn N.Y
83381	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Div of Amerace Esna Corp	Brookfield Mass.

CODE NO	MANUFACTURER	ADDRESS
83502	Grant Pulley and Hardware Co	West Nyack, N.Y
13594	Burroughs Corp. Electronic Components Div	Plainfield N J
13831	U S. Radium Corp	Morristown N J.
23811	Yardney Laboratories Inc	New York N Y.
31131	Arco Electronics, Inc	Great Neck N Y
31311	TRW Capacitor Div	Ogallala Neb.
36114	RCA Corp Electronic Components	Harrison N J
83133	Eastmal Filter Co.	Newark, N J
81171	Marco & Oak Industries a Div of Oak Electro/netics Corp	Anaheim Calif
11316	Philco Corp Lansdale Div	Lansdale Pa
93535	Stockwell Rubber Co Inc	Philadelphia Pa.
83929	Tower-Olschan Corp.	Bridgeport, Conn
88116	Cutler-Hammer Inc Power Distribution and Control Div Lincoln Plant	Lincoln Ill.
13341	Litton Precision Products Inc, USECO Div Litton Industries	Van Nuys, Calif
90634	Gulton Industries Inc	Metuchen, N.J
90113	United-Carr Inc	Chicago, Ill.
91315	Miller Dial and Nameplate Co.	El Monte Calif
91413	Radio Materials Co.	Chicago Ill.
91166	Augat, Inc	Attleboro, Mass
91131	Dale Electronics Inc	Columbus Neb
91612	Elco Corp	Willow Grove, Pa
91115	Honeywell Inc. Div Micro Switch	Freeport Ill
93335	Whitso Inc	Schiller Pk. Ill.
33313	Sylvania Electric Prod Inc Semi-conductor Prod Div	Woburn Mass.
13111	Essex Wire Corp Stemco Controls Div	Mansfield, Ohio
11111	Raytheon Co Components Div Ind Components Oper	Quincy Mass
94154	Wagner Electric Corp Tung-Sol Div	Livingston N J
91331	Southco Inc	Lester Pa.
93361	Leecraft Mfg. Co. Inc.	L.I.C. N.Y
91361	Methode Mfg Co	Rolling Meadows, Ill
95712	Bendix Corp Microwave Devices Div	Franklin Ind
91881	Weckesser Co, Inc	Chicago, Ill
91111	Amphenol Corp Amphenol Controls Div	Janesville Wis
91461	Industrial Retaining Ring Co	Irvington, N J
11762	IMC Magnetics Corp. Eastern Div	Westbury, N Y
88191	Sealectro Corp	Mamaroneck, N Y
13416	CTC Inc	Cleveland, Ohio
33018	International Electronic Research Corp.	Burbank Calif
11921	Rembrandt, Inc.	Boston Mass.

Reference Designator	Description	Quantity	Mfr Part # or Type	Mfr	Mfr Code	hp Stock No	RD
C100	fxd, film [illegible] 900 µf 200V	[illegible]	[illegible]P82[illegible]	Sprague	56289	[illegible]0-01[illegible]	[illegible]
C[illegible]	fxd, film [illegible] 0047µf 100V	[illegible]	[illegible]P4[illegible]	Sprague	[illegible]	[illegible]0-01[illegible]	[illegible]
C300	fxd, film 0.2[illegible]µf [illegible]V	1	[illegible]P2[illegible]	Sprague	[illegible]	[illegible]	[illegible]
C[illegible]	fxd, film [illegible] 001µf 100V	[illegible]	[illegible]0292	Sprague	5[illegible]	[illegible]0-0153	[illegible]
C300,[illegible]	fxd film [illegible] 00[illegible]µf 100V	[illegible]	[illegible]52	Sprague	[illegible]	[illegible]-0154	[illegible]
C500	fxd, elect 14,400µf 34V	1	D40073	HLAB	[illegible]	[illegible]0-1900	1
C501	fxd, paper [illegible] [illegible]µf 400V	[illegible]	[illegible]094	Sprague	[illegible]	[illegible]160-[illegible]	1
C[illegible]	fxd, elect 325µf [illegible]V	[illegible]	D34656	HLAB	[illegible]	[illegible]-[illegible]502	[illegible]
C[illegible] [illegible], [illegible] [illegible]	fxd, elect. 5µf [illegible]V	[illegible]	D336[illegible]	HLAB	[illegible]	[illegible]-[illegible]	[illegible]
C[illegible]	fxd, elect. 1µf 15V	1	150D-1[illegible]5X9035A2	Sprague	56[illegible]	[illegible]-0201	[illegible]
C7[illegible]	fxd, elect. 1µf 50V	1	[illegible]D105G[illegible]	Sprague	[illegible]	[illegible]	[illegible]
C[illegible]	fxd film 0 1µf [illegible]V	1	101[illegible]	Sprague	56200	1100-1100	1
C601	fxd, elect 1500µf [illegible]V	1	D1[illegible]53	HLAB	0[illegible]	0100-1804	1
C[illegible]	fxd, elect. 40µf 50V	[illegible]	D1[illegible]	HLAB	[illegible]	[illegible]	[illegible]
C1[illegible]	fxd elect 3000µf [illegible]V	1	D4[illegible]	HLAB	[illegible]	0100-1001	1
C[illegible]4	NOT ASSIGNED	-	-	-	-	-	-
C[illegible]	fxd elect. [illegible].7µf 15V	1	150D[illegible]	Sprague	[illegible]	[illegible]	[illegible]
C900	fxd elect 20µf 50V	1	30D206G050DC4	Sprague	56200	0100-[illegible]	1
CR100-[illegible]2,200,300, 10[illegible],[illegible],700-711, 102 [illegible],[illegible] [illegible] [illegible]	Diode si. 2[illegible]mA 200PRV	[illegible]		HLAB	[illegible]	1901-[illegible]33	[illegible]
CR[illegible]0,100	Rect. si 12A@150°C 100PRV	1	1N1[illegible]A	R C A	[illegible]	1901-[illegible]	[illegible]
CR4[illegible],[illegible],404, [illegible] [illegible],[illegible] 111 001	Rect. si. 500mA 100PRV	[illegible]	1N[illegible]153	R.C.A	[illegible]	[illegible]	[illegible]
C[illegible],[illegible], [illegible]-[illegible]	Diode si. 200mA 11PRV	[illegible]		HLAB	[illegible]	1901-[illegible]411	[illegible]
CR101,103	Rect si [illegible]A@11[illegible]°C [illegible]PRV	[illegible]	A[illegible]	G.I	[illegible]	1901-[illegible]	2
C[illegible],[illegible]	DCA 12.5A 200PRV	2	[illegible]N1[illegible]	R C.A	01711	1014-1011	2
D[illegible]	Lamp, neon (part of [illegible] ass'y) REF			HLAB	[illegible]	21[illegible]-[illegible]	2
F1	Fuse cartridge 4A	1	[illegible]12004	Littelfuse	[illegible]	[illegible]-[illegible]	1
Q100 200	NPN [illegible] amp si	[illegible]		HLAB	[illegible]	1[illegible]5[illegible]-0220	2
Q[illegible],[illegible]1, [illegible]-[illegible]3	NPN si.	[illegible]				[illegible]-[illegible]	1
Q1[illegible]2,[illegible].7[illegible]1 [illegible] [illegible]	NPN si	[illegible]	[illegible]N34[illegible]	G E	[illegible]	[illegible]-[illegible]	[illegible]
Q[illegible],400	Power NPN si. β-36 @ 4ADC	[illegible]		HLAB	[illegible]7	[illegible]	0
Q401	NOT USED	-	-	-	-	-	-
Q[illegible]	PNP si	1	[illegible]161	R.C A	[illegible]35	[illegible]	1
Q[illegible],[illegible],[illegible] [illegible]2,[illegible]3	PNP si	[illegible]	2N2907A	Sprague	[illegible]200	[illegible]-[illegible]59	[illegible]
Q[illegible]	NPN dif amp si.	[illegible]		HLAB	0[illegible]	[illegible]-[illegible]201	1
Q[illegible]	NOT ASSIGNED	-	-	-	-		-
[illegible]100,[illegible]02,[illegible]	fxd met film 160K±1% 1/8w	[illegible]	Type CEA T-O	I.R C.	[illegible]77[illegible]	0698-[illegible]0	[illegible]
[illegible]101,[illegible],[illegible]	fxd met film [illegible]K±1% 1/8w	[illegible]	Type CEA T-O	I R C	07716	07[illegible]-[illegible]461	[illegible]
[illegible]102,10[illegible],[illegible]04	fxd, met film 432K±1% 1/8w	[illegible]	Type CEA T-O	I R.C	[illegible]77[illegible]	[illegible]-0480	[illegible]
[illegible]103	fxd, comp 430±5% ½w	[illegible]	[illegible]-4[illegible]	A B	[illegible]	0686-43[illegible]	[illegible]
[illegible]104	fxd, ww 430±5% [illegible]w 20	[illegible]	[illegible]42E40[illegible]	Sprague	5628[illegible]	[illegible]-1001	[illegible]
[illegible]105 [illegible]06	fxd met film [illegible]0K±1% 1/8w	[illegible]	Type CEA T-O	I R C	[illegible]77[illegible]	0698-[illegible]	[illegible]
[illegible]10[illegible],[illegible]00,[illegible]13	fxd. met. film 1.5K±1% 1/8w	1	Type CEA T-O	I.R C	077[illegible]	07[illegible]-[illegible]487	[illegible]

Reference Designator	Description	Quantity	Mfr. Part No. or Type	Mfr.	Mfr Code	⊛ Stock No	16
R107 205	fxd met film 17 1 K_Ω ±1% 1/8w	1	Type CEA T-O	I. R. C.	11116	0111-0101	1
1108	fxd comp 130 K_Ω ±5% ½w	1	EB-3341	A. B.	01181	0688-3341	1
1181	fxd comp 39Ω ±5% ½w	1	EB-3905	A. B.	01181	0688-3901	1
1012.111	fxd comp 36K_Ω ±1% ½w	1	EB-3135	A. I	11111	1101-1111	1
1011	fxd comp 75Ω ±5% ½w	1	EB-7506	A. I	11111	1101-1110	1
1101	fxd comp 1 1K_Ω ±5% ½w	1	EB-6225	A. B.	01111	1001-6111	1
1306.111	fxd. comp 1K_Ω ±5% ½w	1	EB-1025	A. I	11111	0111-1020	1
1101	var ww 10K_Ω	1	Series 14	C T S	11451	1100-1001	1
1381	fxd. comp 1 1K_Ω ±5% ½w	1	EB-1125	A. I	11111	1111-1111	1
R380	fxd. ww 1K_Ω ±1% 10w	1	Type 811	W L	10111	1111-0011	1
1310	fxd. comp 11K_Ω ±5% ½w	1	EB-4135	A. B	11111	0100-4100	1
R311	fxd. ww 2.1Ω ±5%	1	Type MW/H	I. R. C.	01111	1111-1111	1
1311 111,112	fxd. ww 100Ω ±1% ½w	3	EB-1015	A. I	11111	1681-1111	1
1313	fxd. ww 11K_Ω ±5% ½w	1	EB-1035	A. I	41111	1681-1111	1
1161	Strap	1		HLAB	09114		1
1401	LEAVE OPEN						
1500	fxd. ww 300Ω ±5% 10w	1	Type 10XM	W L	11111	1111-0114	1
1101 102	fxd. comp 47Ω ±1% ½w	1	EB-4705	A I	41111	1111-1101	1
1100	fxd. comp 110Ω ±5% ½w	1	EB-1131	A. I	41111	1101-1010	1
1108	fxd. comp 101 K_Ω ±1% ½w	1	EB-1041	A. I	41141	0011-1115	1
R601	fxd. met film 1K_Ω ±1% ½w	1	Type CEB T-O	I. R. C.	07114	0111-4131	1
R601.611	fxd. met film 1 11K_Ω ±1% ½w	1	Type CEB T-O	I. R. C	41114	0198-3134	1
1611	fxd met. film 2K_Ω ±1% ½w	1	Type CEB T-O	I R C	17114	0117-0738	1
R611,606,108	fxd comp SELECTIVE ±5% ½w	4	Type EB	A. B.	41111		1
1611.608-111	fxd met. film 1 1K_Ω ±1% ½w	1	Type CEB T-O	I. I C	17711	0686-1111	1
1614	fxd met film 1 11K_Ω ±1% ½w	1	Type CEB T-O	I R. C.	17711	0611-3211	1
1111	fxd met. film 150Ω ±1% ½w	1	Type CEB T-O	I. I C.	41111	0698-1111	1
1111	fxd. ww 200Ω ±5% 3w	1	242E 3915	Sprague	56100	0811-1714	1
1110	fxd. met ox 11Ω ±5% 2w	1	Type C128	Corning	11100	0611-3620	1
1111	fxd. comp 14Ω ±5% ½w	1	EB-1405	A. B.	11111	0611-1111	1
1102	fxd ww 1.1K_Ω ±1% 3w	1	1136-1136	Sprague	11381	0611-1111	1
1703	fxd comp 1 9K_Ω ±5% ½w	1	EB-3935	A. I	11111	0611-1111	1
1714	fxd comp 1 1K_Ω ±5% ½w	1	EB-1135	A. I	11111	0611-4111	1
1701	fxd. comp 110K_Ω ±5% ½w	1	EB-1145	A. B.	11111	0611-1101	1
1111	fxd. comp 1.1Ω ±1% 1w	1	GB-0475	A. B.	41121	0611-9171	1
1101	fxd. comp 1 7K_Ω ±1% ½w	1	EB-4725	A. I	41111	1116-4701	1
4100	fxd comp 1 1K_Ω ±5% ½w	1	EB-3625	A. I	11111	0611-5111	1
1001	fxd. comp 1 1K_Ω ±5% ½w	1	EB-1225	A. B.	11111	0611-8011	1
1111	fxd. comp 110K_Ω ±5% ½w	1	EB-1345	A. I	11111	1505-4341	1
1111	var ww 5K_Ω	1	Type 110-F4	C T S.	11136	0100-1124	1
1112	fxd comp 12K_Ω ±5% ½w	1	EB-1135	A. I	11111	1111-1111	1
4113	fxd comp 11K_Ω ±5% ½w	1	EB-1135	A. I	41111	1686-9111	1
1800	fxd ww 0 2Ω ±10% 40w	1	ZBR-37/5400	H. H	13970	1010-0011	1
1103	fxd. ww 2K_Ω ±5% 3w	3	1125 2025	Sprague	11201	1111-1001	1
R807	fxd. ww 7 1K_Ω ±5% 3w	1	242E-7525	Sprague	11201	0111-1811	1
R809 811	var ww 1 1K_Ω -1K_Ω DUAL	1		HLAB	40111	0100 1102	1
R811 011	var ww 1K_Ω -5K_Ω DUAL	1		HLAB	09111	1108-0896	1
R811	fxd comp 130K_Ω ±5% ½w	1	EB-4335	A. I	01111	0808-1135	1
R811	fxd comp 82Ω ±5% ½w	1	EB-6205	A. B.	11121	0080-0201	1
R811	fxd comp 27K_Ω ±5% ½w	1	EB-2735	A. B.	01111	1111 2735	1
R811	fxd met film 10K_Ω ±1% 1/8w	1	Type CEA T-O	I. I C	07116	1117-0011	1
R822	fxd comp 11K_Ω ±5% ½w	1	EB-8235	I I	07111	0888-0035	1
R823	fxd met. film 12K_Ω ±1% 1/8w	1	Type CEA T-O	I. R. C.	07716	0091-1088	1
R824	fxd comp 11K_Ω ±5% ½w	1	EB-3631	A. B.	41121	0080-1135	1
R811	fxd met ox 110Ω ±5% 2w	1	Type C425	Corning	16011	0090-3625	1
R816	fxd comp 0 38Ω ±5% ½w	1	EB-3325	A. B.	41111	0888-3325	1
R811	fxd ww 3Ω ±5% 3w	1	242E3R05	Sprague	58111	0811-1124	1

Reference Designator	Description	Quantity	Mfr Part # or Type	Mfr	Mfr Code	Stock No	RS
4328	fxd. comp 300KΩ ±5% $\frac{1}{4}$w	1	E0-3045	A 0	01121	0006-3645	1
4350	fxd mot film 72KΩ ±1% 1/8w	1	Type CEA T-O	L 4 C	07710	0098-3260	1
R451 854, 450, 454	fxd mot film 000Ω ±1% 1/8w	4	Type CEA T-O	1 4 C	07710	0757-1099	1
R851 053	fxd mot film 100Ω ±1% 1/8w	2	Type CEA T-O	1 4 C	07710	0757-0401	1
4055 805	var ww 250Ω	2	Type 110-F4	C T S	11136	7100-0430	1
R457	fxd met film 5.2KΩ ±1% $\frac{1}{4}$w	1	Type CEB T-O	1 R C	07716	0454-5144	1
R450	fxd met film 9 31KΩ ±1% $\frac{1}{4}$w	1	Type CEB T-O	1 R C	07710	0044-3743	1
R040 003	fxd. met. film 365Ω ±1% $\frac{1}{4}$w	3	Type CEB T-O	1 R C	07710	0757-0773	1
0061 407 064 307	fxd. met. film 3 40KΩ ±1% $\frac{1}{4}$w	4	Type CEB T-O	1 R C	07714	0000-4042	1
R000	fxd. met. film 750Ω ±1% 1/8w	1	Type CEA T-O	1 R C	07710	0757-0470	1
R608, 440	fxd. met. film 34 5KΩ ±1% $\frac{1}{4}$w	2	Type CEB T-O	L R C	07710	0757-0765	1
4870	var ww 10KΩ	1	Type 110-F4	C T S	11230	2100-0396	1
4872	fxd. met film 2KΩ ±1% 1/8w	1	Type CEA T-O	1 4 C.	07710	0757-0283	1
4000	fxd. comp 20KΩ ±5% $\frac{1}{2}$w	1	EB-3035	A. 4.	01121	0600-3035	1
R901	fxd comp 100KΩ ±5% $\frac{1}{2}$w	1	E0-1045	A. 4	01121	0686-1045	1
R002	fxd comp 3KΩ ±5% $\frac{1}{2}$w	1	EB-3035	A. 4.	01121	0680-3075	1
4903	fxd comp 33KΩ ±5% $\frac{1}{2}$w	1	EB-3335	A. 4.	01121	0684-3335	1
S1	Switch pilot lt (red) ON/OFF	1	54-41081-24A1H	Oak	57034	3101-0100	1
S3	Switch rotary (meter)	1	(3 pole 4 position)	HLA4	00t82	3100-1010	1
T700	Pulse Transformer	1		HLAB	00183	9100-1824	1
T000	Power Transformer	1		HLAB	00103	9100-1847	1
T001	Bias Transformer	1		HLA0	00107	9100-1937	1
VR300	Diode, zener 4 33V±5% 400mw	1		HLA0	00182	1907-3070	1
VR600	Diode, zener 4 4V±5% 500mw	1	1N7163	U S Semcor	06751	1907-0702	1
VR601	Diode zener 6 2V±5% 4 22V	1	1N071	H A Elect	06440	1907-0761	1
	Meter 3½ DUAL, 0-24V 0-6A	1		HLAB	00142	1120-1135	1
	Meter bezel ½ MOD.	1		HLAB	00187	4040-0294	1
	Meter Spacer	4		HLAB	00157	1400-0750	1
	Fuseholder	1	347014	Littelfuse	75015	1400-0004	1
	Binding Post (Maroon)	1	DF71Mn	HLAB	00142	1510-0040	1
	Binding Post (Black)	7	DF71BC	Superior	58474	1510-0030	1
	Rubber feet	4	M4-50	Stockwell	87575	0403-0088	1
	Knob 5/8 dia. (Black)	1		HLAB	00142	0370-0084	1
	Knob insert pointer 5/8 dia	2		HLAB	00102	0370-0101	1
	Knob ½ dia , (Red)	2		HLAB	00102	0370-0170	1
	Barrier Strip	1		HLAB	00182	0360-1234	1
	Line cord 7½' PH 151	1	KH-4096	Beldon	70503	8110-0050	1
	Strain Relief Bushing	1	84-SP-1	Heyco	34520	0400-0013	1
	Mica washer	2	734	Reliance	08530	0340-0174	1
	Mica washer 1" dia	4		Reliance	08530	2100-0710	1
	Mica washer 5/8 dia	7		Reliance	08530	2150-0708	1
	Delrin Bushing	6		HLA4	04142	0340-0100	7
	Delrin Bushing	7		HLAB	04142	0340-0171	1
	Jumper (Barrier Strip)	8	422-13-11 012	Cinch	71785	0360-1274	7
OPTION 07							
	Voltage 10-Turn Potentiometer	1	Series 0400	1 4 C	07710	2100-1805	1

Reference Designator	Description	Quantity	Mfr. Part # or Type	Mfr	Mfr Code	Stock No	RS
OPTION 08:							
	Current 10-Turn Potentiometer	1	Series 6400	I.R.C.	07716	2100-1864	1
OPTION 09:							
	Voltage/Current 10-Turn Pots	1	(Includes:)				
	Voltage 10-Turn Potentiometer	1	Series 6400	I.R.C.	07716	2100-1865	1
	Current 10-Turn Potentiometer	1	Series 6400	I.R.C.	07716	2100-1864	1
OPTION 13:							
	Voltage Decadial Control	1	(Includes:)				
	Voltage 10-Turn Potentiometer	1	Series 6400	I.R.C.	07716	2100-1865	1
	Decadial Control	1	RD-411	I.R.C.	07716	1140-0020	1
OPTION 14:							
	Current Decadial Control	1	(Includes:)				
	Current 10-Turn Potentiometer	1	Series 6400	I.R.C.	07716	2100-1864	1
	Decadial Control	1	RD-411	I.R.C.	07716	1140-0020	1

APPENDIX A
Option 11, Overvoltage Protection "Crowbar"

DESCRIPTION:

This option is installed in DC Power Supplies, 6282A, 6285A, 6286A, 6290A, 6291A, and 6296A, and tested at the factory. It consists of a printed circuit board, screwdriver-type front panel potentiometer, and six wires that are soldered to the main power supply board.

The crowbar monitors the output voltage of the power supply and fires an SCR that effectively shorts the output when it exceeds the preset trip voltage. The trip voltage is determined by the setting of the CROWBAR ADJUST control on the front panel. The trip voltage range is as follows:

Model	6282A	6285A	6286A	6290A	6291A	6296A
Trip Voltage Range	3–13V	2–22V	2–22V	5–42V	5–42V	6–66V

To prevent transients from falsely tripping the crowbar, the trip voltage must be set higher than the power supply output voltage by the following margin: 7% of the output voltage +1V. The margin represents the minimum crowbar trip setting for a given output voltage; the trip voltage can always be set higher than this margin.

OPERATION:

1. Turn the CROWBAR ADJUST fully clockwise to set the trip voltage to maximum.
2. Set the power supply VOLTAGE control for the desired crowbar trip voltage. To prevent false crowbar tripping, the trip voltage should exceed the desired output voltage by the following amount: 7% of the output voltage +1V.
3. Slowly turn the CROWBAR ADJUST ccw until the crowbar trips, output goes to 0V or a small positive voltage.
4. The crowbar will remain activated and the output shorted until the supply is turned off. To reset the crowbar, turn the supply off, then on.

Table A-1. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
C1	fxd, film .1µF 200Vdc	1	192P10492	56289	0160-0168	1
CR1-4	Diode, Si, 200mA 200prv	4	1N4858	09182	1901-0022	4
CR6	Rect, Si, 12A 100prv	1	1N1200A	02735	1901-0002	1
CR7	SCR 8A 200prv	1	2N3669	02725	1884-0010	1
Q1	SS NPN Si,	1	2N2714	03508	1854-0027	1
Q2	SS NPN Si,	1	2N3817	02508	1854-0087	1
Q3	SS PNP Si,	1	TZ173	56289	1852-0099	1
R1	fxd, comp 750Ω ±5% ½W	1	EB-7515	01121	0686-7515	1
R2	fxd, comp 200KΩ ±5% ½W	1	EB-2045	01121	0686-2045	1
R3	fxd, comp 10KΩ ±5% ½W	1	EB-1035	01121	0686-1055	1
R4	fxd, comp 3.9KΩ ±5% ½W	1	EB-3925	01121	0686-3925	1
R6	fxd, comp 4.7Ω ±5% ½W	1	EB-47G5	01121	0698-0001	1
R7	fxd, comp 47Ω ±5% ½W	1	C425	15299	0698-3625	1
R8	fxd, met, ox, 180Ω ±5% 2W	1	Type C428	16299	0698-3628	1
R9	fxd, met, film 1.21KΩ ±1% 1/8W	1	Type CEA T-0	07716	0757-0274	1
R10	fxd, comp 390Ω ±5% 3W	1	2420	56289	0811-1799	1
R11	var, ww 5KΩ ±5% 2W	1		09182	2100-1853	1
R12	fxd, ww 0.125Ω ±5% 5W	1		09182	0811-1848	1
R13	fxd, comp 200KΩ ±5% ½W	1	EB-2045	01121	0686-2045	1
T1	Pulse Transformer	1		09182	9100-1824	1
VR1	Diode, zener 5.62V ±5%	1	1N2512	07716	1902-3104	1
	MISCELLANEOUS					
	Bushing, Potentiometer	1		09182	1400-0052	
	Nut, Hex	1		09182	2950-0024	
	Printed Circuit Board Assembly, Includes Components	1		09182	06285-60021	
	Printed Circuit Board, Bracket	1		09182	5000-6225	
	Modified Front Panel, Includes Components	1		09182	06285-60003	

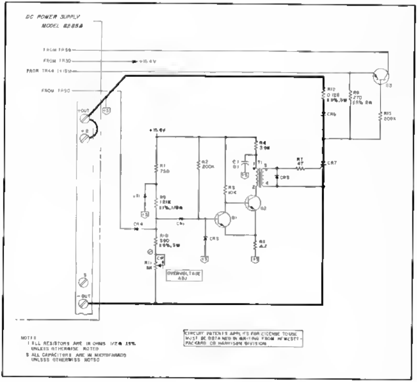
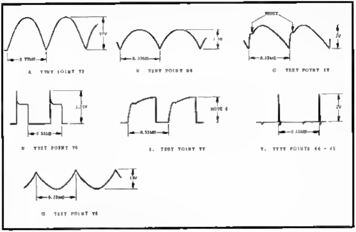


Figure A-1. Model 6285A Overvoltage Protection Crowbar



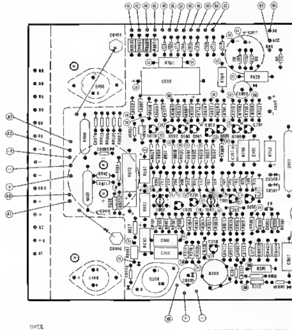
NOTES: 1. ALL WAVEFORMS TAKEN WITH 115VAC 60Hz SINGLE-PHASE INPUT AT MAXIMUM RATED OUTPUT VOLTAGE AND NO LOAD CONNECTED. AMPLITUDES ARE TYPICAL ±10%.

2. OSCILLOSCOPE DC COUPLED AND REFERENCED TO T.P. 10 UNLESS OTHERWISE INDICATED.

3. WAVEFORMS ARE NOT DRAWN TO SCALE.

4. AMPLITUDE OF WAVEFORM TP 2, P 47 VARIES WITH DIFFERENT MODELS AS FOLLOWS:

MODEL NO.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
VOLTAGE	+15V	+17V	[illegible]	20V	+17V	+20V



NOTE

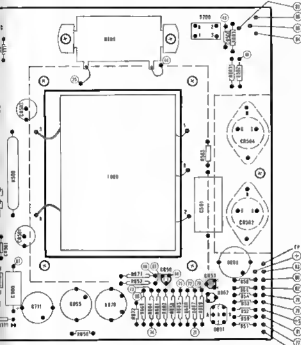
1. CATHODES OF ALL DIODES FACE TOWARDS BOTTOM OF BOARD

2. ALL TRANSISTOR BASES FACE TOWARDS THE RIGHT OF BOARD EXCEPT OTHERWISE NOTED

3. ON MODELS 6284A, 6285A, 6286A ... MOUNTED ON HEAT SINK NOT PR...

4. ON MODELS 6284A AND 6286A C... MOUNTED ON PRINTED CIRCUIT BO...

5. ON MODELS 6285A, 6290A, 6291A ... ARE NOT USED AND R400 IS ...



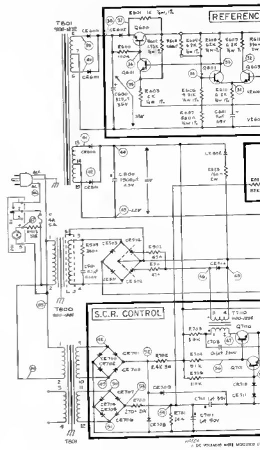
G296A AND G291A CR400 CR501 CR503 AND CR809
...OT PRINTED CIRCUIT BOARD

...96A CR400 CR501 CR503, CR809 ARE
...IT BOARD NOT HEAT SINKS

... G291A AND G296A R401 AND Q401
...DO IS REPLACED WITH A JUMPER

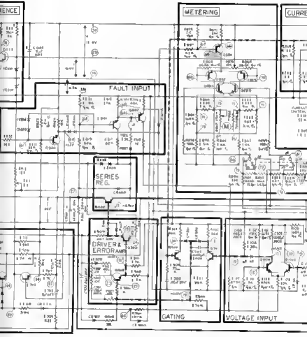
COMPONENT LOCATION - PRINTED CIRCUIT BOARD

B-5950-5227 1



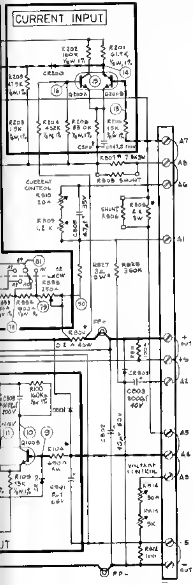
NOTES
A DC VOLTAGES WERE MEASURED

TP-1 Rev 70



RENCE
METERING
CURRE
FAULT INPUT
SERIES REG.
DRIVER & ERROR AMP
GATING
VOLTAGE INPUT

Model 6



Model 6285A, Schematic Diagram

MANUAL CHANGES

Model 6285A DC Power Supply
Manual HP Part No. 06285-90001

Make all corrections in the manual according to errata below, then check the following table for your power supply serial number and enter any listed change(s) in the manual

SERIAL		MAKE
Prefix	Number	CHANGES
6K	0181-0221	1
6K	0222-0251	1, 2
6K	0252-0281	1, 2, 3
7M	0282-0341	1, 2, 3, 4
7M	0342-0416	1 thru 5
7M	0417-0461	1 thru 6
7M	0462-0686	1 thru 7
All		Errata
1147A	0687-0706	1 thru 9
1147A	0707-1206	1 thru 10
1549A	1207-1218	1 thru 11
1550A	1219-up	1 thru 12

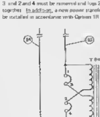
CHANGE 1

In the replaceable parts table change R308 from 50Ω to 40Ω

CHANGE 2

In the replaceable parts table make the following changes:
VR600 Change to 1N2163A, Motorola, HP Part No. 1902-0762.
T801 Change T801 to HP Part No. 9100-2184

On the schematic, the primary of bias transformer T801 is connected as shown in the sketch below for 115Vac operation. For 230Vac operation the jumpers between lugs 1 and 3 and 2 and 4 must be removed and lugs 2 and 3 connected together. In addition, a new power transformer T800, must be installed in accordance with Option 1R



CHANGE 3

In the replaceable parts table, make the following changes:
CR603 Add new diode CR603, 200mA 200prv HP Part No. 1901-0033.
▶ R313 Change to 1KΩ, (Selected) ½W HP Part No. 0686-1025.
R601 Change to 4.22Ω ¼W HP Part No 0698-4590
R706 Change to 4.7Ω, 2W BWH IRC
R870 Change to 5KΩ potentiometer HP Part No. 2100-1824
R871 Change to 750Ω ±1% 1/8W HP Part No 0757-0420
R872 Delete resistor R872
VR800 Add new zener diode VR800 4.22V HP Part No. 1902-3070.

On the schematic, connect new diode CR603 across VR600 in the reference circuit. Anode to +S and cathode to +8.4 volts. Also delete R872 in the meter circuit and connect VR800 in its place. Anode to base of Q850 and cathode to +15.4 volts.

CHANGE 4

On the title page change serial number prefix from "6K" to "7M"

In the replaceable parts, delete S1 (switch/pilot light) and replace with separate toggle switch (S1 HP Part No. 3101-0084) and pilot light (DS1 HP Part No. 1450-0048)

Schematic connections to these two components remain the same, except that they are physically separate. Also on the schematic, change R606 in the reference circuit to 6.2KΩ.

CHANGE 5

In the replaceable parts table change R626 to 3.9K, ±5%, ½W, HP Part No. 0686-3925.

CHANGE 6

In the replaceable parts table make the following changes:
R712 Change to 15KΩ ±5%, ½W A. B. HP Part No. 0686-1535.

CHANGE 7

In the replaceable parts table change R501 and R502 to 22Ω ±5% ½W HP Part No. 0686 2205.

ERRATA

Q702 800 860, 862 863 Change to 2N2907A, Sprague, 56289 HP Part No 1853-0099

On page 3 2 Figure 3-4 disconnect strap between terminals A4 and A5 and connect A5 to +S.

On page 3 3 Figure 3-6 disconnect strap between terminals A7 and A8 and connect A8 to +S.

On page 5-10 paragraph 5-53, Step b, change it to read as follows
   b. Connect dc voltmeter between TP27 and emitter of series regulator transistor(s)

On page 5-8 in Step 3-b of Table 5-4 change the last sentence to read
   If it is not proceed to Step 4

In specifications table on page 1 3, change the specification on output impedance to read
   1 milliohm in series with 1 microhenry

On page 5-8, in step (g) of paragraph 5-22 and step (i) of paragraph 5-23, change the maximum variation in differential voltmeter reading to 10 7 millivolts.

CHANGE 8

In the replaceable parts table make the following changes
   R702 Change to 1 5K 3W ww HP Part No. 0811 1806
   R709 Change to 1 8K, ½W HP Part No 0686 1825

CHANGE 9

In the replaceable parts table change the HP Part No. of CR501, CR503 from 1901-0323 to 1901-0318

CHANGE 10

The standard colors for this instrument are now mint gray (for front panel) and olive gray (for all other external surfaces). Option X95 designates use of the former color scheme of light gray and blue gray. Option A85 designates use of a light gray front panel with olive gray used for all other external surfaces. New part numbers are shown below

ERRATA

In the parts list on page 6-6, change the HP Part No. of CR501 and CR503 to 1901-0317

ERRATA

In table 1 1 and paragraph 5-20 change the INTERNAL IMPEDANCE AS A CONSTANT VOLTAGE SOURCE (Output Impedance) specification to read as follows
   OUTPUT IMPEDANCE (TYPICAL) Approximated by a 0-001 milliohm resistance in series with a 1 microhenry inductance

DESCRIPTION	HP PART NO		
	STANDARD	OPTION A85	OPTION X95
Front Panel Lettered	06285-00004	06285-00001	←
Heat Sink Assembly	5000-7968	←	5000-6131
Rear Chassis	5000-9405	←	5000-6103
Cover Top	5000-9431	←	5000-6104
Chassis Right Side	5000-9406	←	5000-6098
Chassis, Left Side	5000-9407	←	5000-6099

CHANGE 11

All primary ac connections have been removed from the circuit board and are now made directly to the transformer primaries. Pilot light resistor R903 has been removed from the PC board and is now on a new terminal strip (0360-1000) mounted on the SCR heatsink assembly. These changes do not affect the circuit schematic.

CHANGE 12

In this supply, main power transformer T900 has been replaced by a new transformer with a dual winding primary for 115/230Vac operation. The new transformer (HP Part No. 06285-80091) replaces both T900 transformers previously used in this model for 115V and 230V operation. Since it is no longer necessary to replace T900 to convert the supply from 115V to 230V operation, option 010 (which equipped the supply for 230V operation only) has been discontinued, to be replaced by a new Option 028. Option 028 modifies the standard 115V unit to a 230V unit as described below.

To convert the supply for 230V operation:

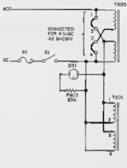
a. Remove the jumpers from between terminals 1 and 3, and 2 and 4 of T900.

b. Install a jumper between terminals 2 and 3 on T900.

c. Replace F1 with a 2A 250V fuse, 2100-0002.

Note: Due to the circuit changes shown below, it is no longer necessary to change any jumper connection at T901. The dual primary windings of T901 are now permanently wired in parallel across winding 3-4 of T900. The pilot light, in series with R903, is also connected across this winding.

The revised primary circuit schematic is shown below.



ERRATA

In replaceable parts list, change HP Part No. of pilot lamp DS1 to 1450-0566.

► Effective January 1st, 1977, Options 007 (10-turn voltage control) and 008 (10-turn current control) are no longer available individually, but they are still available combined as Option 009. Likewise, Options 013 (10-turn voltage control with decadial) and 014 (10-turn current control with decadial) are no longer available individually, but they are available combined into a single new option designated Option 016. Make these changes wherever Option 007, 008, 013, or 014 is mentioned in the manual.

The front panel binding posts have been changed to a type with better designed insulation. Delete the two types of posts listed on page 6-7 of the parts list and add: black binding post, HP Part No. 1510-0114 (qty. 2) and red binding post, HP Part No. 1510-0115 (qty. 1).

In Table 1-1 and paragraph 5-20, change the internal impedance as a constant voltage source (output impedance) specification to read as follows: Output Impedance (typical): Approximated by a 1 milliohm resistance in series with a 1 microhenry inductance.

Indicate on the schematic with a dagger (†) to show that 1k is the nominal value for R313. The value for R313 is factory selected to optimize the range of transient adjust pot R307.

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